United Nations A/AC.105/729/Add.1

General Assembly

Distr.: General
28 January 2000

Original: Arabic/English
French/Spanish

Committee on the Peaceful Uses of Outer Space

International cooperation in the peaceful uses of outer space: activities of Member States

Note by the Secretariat

Addendum

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V.00-50598 (E)

I. Introduction

1. In accordance with the recommendation of the Committee on the Peaceful Uses of Outer Space at its fifty-fourth session,[1] Member States have been invited to submit annual reports on their space activities. In addition to information on national and international space programmes, the reports could include information on spin-off benefits of space activities and other topics as requested by the Committee and its subsidiary bodies.

2. The information submitted by Member States as at 30 November 1999 is contained in document A/AC.105/729. The present document contains information submitted by Member States between 1 December 1999 and 25 January 2000.

II. Replies from Member States

France

[Original: French]

1. France participates in the programmes of the European Space Agency (ESA) and conducts a national space programme. The present report deals mainly with the latter.

A. Access to space

2. As the successor to the French Diamant programme, the ESA Ariane programme was established at the suggestion of the Centre national d'études spatiales (CNES) and, since 1979, has ensured Europe's independence with regard to space launch vehicles. While France was instrumental in the establishment of Ariane, the technical, industrial and commercial success of the launcher has to be attributed to Europe as a whole, which by that achievement demonstrated its exceptional capabilities within the framework of a common policy.

3. There was considerable activity in 1999.

1. Launches carried out

4. Although only two launches were carried out during the first six months (flight 116 with the Arab Satellite Communications Organization and Skynet satellites, and flight 117 with the Indian National Satellite System (INSAT) satellite), there was sustained activity during the second half of the year with eight launches, including the fourth Ariane-5 launch (first commercial launch):

(a) Flight 118 on 12 August (Telkom);

(b) Flight 120 on 4 September (Koreasat);

(c) Flight 121 on 25 September (Telstar-7);

(d) Flight 122 on 19 October (Orion-2);

[1] *Official Records of the General Assembly, Fifty-fourth Session, Supplement No. 20* (A/54/20), para. 119.

(e) Flight 123 on 13 November (GE-4);

(f) Flight 124 on 3 December (Hélios-1B and Clémentine);

(g) Flight 119 (Ariane-5) on 10 December (X-ray multi-mirror (XMM) satellite);

(h) Flight 125 on 21 December (Galaxy-II).

5. The most recent Ariane-4 launch (flight 125) was the launch vehicle's fifty-first consecutive success.

2. Ariane-5 developments

6. The work currently in progress under the Ariane-5 Plus programme should make it possible to meet three objectives: (a) reduced production costs; (b) enhanced performance, in particular in geostationary orbit, to cope with the increase in the number of telecommunications satellites; and (c) upper-stage versatility to allow for multiple reignition, which is necessary for launching satellite constellations.

7. The Ariane-5 Plus programme involves:

(a) A storable-propellant stage (EPS-V) suited to long coasting phases and multiple ignition (Ariane-5 Versatile), which will make it possible to launch 7.4 tons into geostationary transfer orbit in 2002;

(b) A version-A cryogenic upper stage (ESC-A) using the Ariane-4 HM7-B engine, which will make it possible to launch 9 tons into geostationary transfer orbit in 2002;

(c) A version-B cryogenic upper stage (ESC-B) using a new Mesco reignitable engine, which will make it possible to launch more than 9 tons in 2002 and more than 11 tons in 2005 into geostationary transfer orbit.

B. Micro-satellites

8. Thanks to present-day technologies, it is now becoming possible to carry out with a 100 kg mass not only technology demonstration and qualification missions but also important scientific and even major applications missions. CNES has decided to develop a French solution in order to meet the needs of the national scientific and applications communities.

9. The CNES micro-satellite programme has three advantages:

(a) Offers for the launch of auxiliary payloads can be exploited;

(b) Lightweight scientific research missions and also technology development and applications missions can be undertaken quickly and at lower cost;

(c) New methods for project design and management can be tested and developed without undue risk.

10. The aim is to carry out two micro-satellite missions a year.

C. Protéus platform

11. Protéus, a reconfigurable platform for Earth observation, telecommunications and scientific uses, is available for 500 kg satellites. It is suitable for orbits at between 400 and 1,500 km.

12. This project constitutes the first practical application of the policy of close partnership between CNES and industry. The first mission to use a Protéus platform is Jason, which will monitor ocean phenomena as a continuation of the results already obtained from the TOPEX-Poseidon (high-precision altimetric satellite for space oceanography) mission. The Protéus product line is the outcome of the decision taken by CNES to acquire the capacity to carry out missions at low cost and with short lead times.

13. The potential applications of Protéus are also being developed under the Pathfinder Instruments for Cloud and Aerosol Spaceborne Observations/Climatologie étendue des nuages et des aérosols (PICASSO/CENA) mission, which has been officially selected as part of a cooperation arrangement between CNES and the National Aeronautics and Space Administration (NASA) of the United States of America.

D. International Space Station and manned spaceflight

1. International Space Station

14. The automated transfer vehicle (ATV) launched by Ariane-5 will make an important contribution by Europe to the logistic support of the International Space Station. It will also serve as a contribution in kind to the joint operations of the Station. The contract for the constructional works of the project has been awarded by ESA to the firm Aérospatiale-Matra.

15. For the operational phase, the ATV orbital control centre will be situated at the CNES Toulouse site. This choice of location will strengthen France's role in the management of the operations and is consistent with the launch by Ariane-5.

2. Manned spaceflight

16. The Space Transportation System STS-93 mission was completed on 28 July 1999. During the landing phase, Captain Eileen Collins and Michel Tognini were provided with Doppler sensors to evaluate blood flow to the legs and in the brain. The measurements will be used in studying the readjustment of the body's cardiovascular system on return to Earth gravity following a period spent in microgravity conditions.

17. The Perséus mission took place over a period of 188 days, from 20 February to 28 August 1999. It was carried out under the Franco-Russian agreement concluded in December 1996 between CNES and RKK Energia (Russian Energia Rocket and Space Corporation) and involved the flight of a French astronaut and the execution of a scientific and technological experimental programme on board the space station Mir. Jean-Pierre Haigneré, the French member of ESA's European corps of astronauts, was placed at the disposal of CNES for this mission. Claudie André-Deshays, a CNES astronaut, was named as substitute.

18. The Perséus mission is noteworthy for several reasons. It was a Franco-Russian mission in which a Frenchman for the first time served as flight engineer in the Mir crew. Jean-Pierre Haigneré, who also carried out the experimental programme, performed an extravehicular activity. The scientific programme was chosen with a view to obtaining the maximum benefit from the flight's duration.

E. Earth observation

19. Understanding our planet better in order to manage it more effectively by means of Earth observation has now become an everyday reality in many fields owing to the contribution made by satellites. CNES began at an early stage to investigate the possibilities offered by Earth observation from space and its extensive areas of application, which are now part of daily life.

20. The study and observation of the Earth are of scientific, operational and economic importance. In the economic sector, Earth observation by satellite has enabled markets to develop in many fields, such as cartography, crop forecasting, environmental monitoring and natural disaster prevention.

1. Jason

21. The launch will take place during the second half of the year 2000. This is a satellite altimetry mission intended to continue the ocean topography service provided by the TOPEX-Poseidon mission.

2. SPOT-4 and Vegetation

22. The fourth Système pour l'observation de la Terre (SPOT-4) satellite and Vegetation payload are operating normally, as are the operational production and mission centres.

23. The firm Spot Image has announced that, since 8 March 1999, it has supplied over 60 billion km^2 of Vegetation data, representing more than 450 times the area of the Earth's land mass.

24. The scientific community throughout the world is the main user of Vegetation data for the long-term study of environmental changes at the regional or global level. Vegetation data also meet the requirements of operational applications. For example, forest mapping and related updating work are an essential element both for local resource management and for longer-term studies of continental or global climate change. The surveying of areas under cultivation provides access to indicators of the condition of crops, which assists in forecasting yield.

3. Hélios-1B

25. Satellite Hélios-1B of the Direction générale pour l'Armement was launched on 3 December 1999 from an Ariane-4 launch vehicle. CNES then successfully carried out the final positioning of the satellite. The first images were received on 4 December.

4. Japanese Advanced Land Observing Satellite

26. Since a centre is being set up in Europe for processing and distributing data from the Japanese Advanced Land Observing Satellite (ALOS), which is to be launched in late 2002, a preliminary study phase is being conducted by a joint CNES-ESA team. The results are expected by March 2000.

F. Climate and environment studies

27. The scientific priorities are concerned with the monitoring of climate change and major biogeochemical cycles. Since these phenomena occur on a global scale, the corresponding missions are being undertaken on a priority basis at the European or international level.

1. PICASSO/CENA

28. CNES is NASA's main partner in the PICASSO/CENA mission, which was selected at year-end as part of the NASA Earth System Science Pathfinders programme.

29. The PICASSO/CENA mission is aimed at studying the role of clouds and aerosols and their impact on the Earth's radiative balance, a key element in understanding climate. PICASSO/CENA uses an innovative United States instrument comprising an on-board laser infra-red detection and ranging (Lidar) system to measure the vertical cloud and aerosol profile. Two supplementary instruments will define optical aerosol and cirrus properties. France will provide a Protéus platform and infra-red imaging instruments. PICASSO/CENA is due to be launched in 2003.

2. Megha-Tropiques

30. The main applications of the Megha-Tropiques mission relate to seasonal variations in the water cycle and energy exchanges within the land-ocean-atmosphere system in tropical zones. This mission involves important issues for the economic development of countries in tropical areas, primarily with regard to agriculture and the management of water resources.

31. Megha-Tropiques is a small scientific satellite designed for simultaneous observation of water vapour, clouds, precipitation and radiation in the intertropical region. Orbiting at an altitude of 800 km makes it possible to obtain up to six observations a day over the entire region. The satellite will carry on board a Madras microwave radiometer to study rainfall and cloud properties; a ScaRab radiometer for measuring top-of-the-atmosphere flux radiation; and a Saphir microwave profiler to measure atmospheric water vapour distribution.

32. The launch of this mission is scheduled for 2005 with the Indian polar satellite launch vehicle. It is part of the mini-satellite programme, which uses the Protéus platform developed by CNES and Alcatel Space Industries. The Madras radiometer, which is the main instrument to be carried on board, will be developed jointly by CNES and the Indian Space Research Organization (ISRO), with the participation of Matra Marconi Space. The ISRO-CNES cooperation agreement was signed in November 1999.

3. Déméter

33. Déméter is one of the first three missions of the new CNES micro-satellite programme. Déméter will be launched into low-polar orbit in 2001 to study ionospheric disturbances connected with seismic and volcanic activity and to monitor the Earth's electromagnetic environment and Sun-Earth interaction.

4. Picard

34. Picard will be the second mission undertaken on board a micro-satellite. Picard will establish reference measurements of the Sun's diameter and differential rotation and the solar constant in order to determine their variabilities and interaction. These measurements will be used for studying the climatology of the Earth and gaining a better knowledge of helioseismology and the internal structure of the Sun.

G. Astronomy

1. Pronaos

35. The third balloon-mounted flight carrying the Pronaos instrument was conducted by CNES in cooperation with the National Centre for Scientific Research—the Centre for Space Radiation Study and the Institute of Space Astrophysics (IAS)—for the purpose of making astronomical observations in the sub-millimetric sphere. The launch took place on 22 September 1999 from the balloon launch base of NASA's National Scientific Balloon Facility in Fort Sumner, New Mexico (United States).

36. Following a perfect lift-off of the 1.2 million m^3 balloon and the 3-ton basket carrying the instrument, the ascent to flight level at an altitude of 37.5 km in the stratosphere was duly completed. The functioning of the basket and positioning of the payload were in line with expected performance.

37. The Pronaos mission subsequently had to be discontinued when the balloon's trajectory reached the limit of the authorized flying area near the Mexican border. After 11 ½ hours of operation at maximum height, the basket was separated from the balloon and came down by parachute, landing to the south of Alamo Gordo. This mission made it possible to carry out scientific observations covering seven regions of the sky, including five of near interstellar clouds.

2. X-ray multi-mirror mission

38. The second component of ESA's Horizon 2000 programme is the XMM mission, which entails a multi-mirror observatory satellite designed for studying X-rays from near stars to distant active galactic nuclei. France was involved in the production of the European photon imaging camera (EPIC) assembly, which is a set of three X-ray cameras positioned in the focal plane of the mirrors. The instruments contributed by the French laboratories (Atomic Energy Commission, IAS and CESR) and by CNES (radiation monitor) were supplied to ESA. The launch took place on 10 December 1999 (Ariane-5).

H. Planetary studies

1. Mars sample-return mission

39. For several years, NASA has been carrying out a Mars exploration programme, which will culminate with the first return of samples in the year 2008. This latest programme mission will be conducted in cooperation with CNES as part of an agreement currently in course of preparation. The main stages are to be as follows:

(a) In 2003, a lander will be launched from a Delta rocket on to the planet at a site regarded as appropriate for investigating life forms. A rover will be sent out from the lander to collect samples of martian soil and bring them back to the lander. The samples will then be put in a spherical container, which will subsequently be placed in orbit around Mars;

(b) In 2005, the dual launch will take place of a 1,800 kg lander and a 2,700 kg orbiter from an Ariane-5 launch vehicle. The lander will perform the same mission as in 2003 but at a different site. The orbiter will carry the Netlander mission equipment, comprising four landers, each weighing some 60 kg, which it will release in the vicinity of Mars so that they can land on the planet, where a network will be deployed to study the

martian atmosphere, seismology and magnetism. The orbiter, protected by a thermal shield, will then pass through the martian atmosphere, which will reduce its speed and send it into orbit around the planet. Using radio and optical devices, it will search for and pick up the two containers of samples before returning to Earth.

40. Under this programme, CNES will participate in the mission and systems studies, produce the orbiter and the Netlander equipment in cooperation with other European countries and supply an Ariane-5 launch vehicle in 2005, and will take part in the operations and set up the related ground segment.

2. Microscope

41. Microscope, a basic physics project proposed by the National Aerospace Study and Research Establishment and the Observatory of the Côte d'Azur, is scheduled to be carried on board a CNES micro-satellite in Sun-synchronous orbit in 2003 and 2004. Its purpose is to test the principle of equivalence between inert mass and gravitational mass to an accuracy of 10^{-15}, that is, an improvement by a factor of three compared with experiments carried out on the ground. This fundamental test would mean an endorsement of the relativistic theory of gravitation (which assumes this equivalence) and a setback for the theories of unification of fundamental interactions (which predict further interactions violating the equivalence principle). The mission will also provide an opportunity for the qualification of drag-free satellite construction technologies to be used for future scientific space missions.

42. The Microscope satellite essentially comprises two electrostatic differential accelerometers (each containing two cylindrical test masses) linked to an electronic unit; a drag-free and attitude control system installed in the micro-satellite's computer; and field emission electric propulsion units, together with their power and command electronics.

I. Space radiocommunications

43. The field of space radiocommunications is by far the leading area of space-related applications and the one which guides all launch-vehicle policy-making worldwide. This area is destined to undergo long-term development and growth against a background of liberalization of the telecommunications sector and globalization of trade and with the expected expansion of the information society.

1. Stentor

44. Stentor, a telecommunications satellite designed for testing new technologies in orbit, is due to be launched in 2001 and will carry out in-orbit validations and qualifications of the most advanced techniques resulting from the research and development programmes of CNES, France Télécom and the Direction générale pour l'Armement, the partners in this programme. The satellite forms the main element of this technology programme, which covers research and development activities, ground projects and the incorporation of new technologies in industrial product lines. For example, the expertise acquired from the technologies developed for Stentor will be used in the Spacebus (Aérospatiale) and Eurostar (Matra Marconi Space) platform product ranges.

45. The Stentor satellite payload will make it possible to conduct full-scale transmission tests and demonstrate the benefits and performance characteristics of new communications services up to 2009. Stentor, which weighs almost 2,000 kg and has an electrical power

of about 2,400 W and an anticipated useful life of nine years, will be placed in geostationary orbit.

2. Skybridge

46. The Skybridge system will use a constellation of 80 satellites in low orbit to provide both private individuals and businesses with bandwidth capacities whose performance will be similar to that of future high-output land-based technologies (60 Mbps during downlink to the user and 2 Mbps during uplink). Skybridge will allow rapid access to the Internet and to different interactive services such as tele-working, distance learning, video conferencing and interactive games. As from 2001, the services will be offered via local service providers and telecommunications operators. In partnership with Alcatel, CNES has been involved in the feasibility and pre-definition studies for the Skybridge system, in particular those relating to the satellite constellation (geometry, number of satellites and deployment strategies) and its ground control component.

3. Wideband European Satellite Telecommunications

47. The Wideband European Satellite Telecommunications (WEST) system is a project initiated by Matra Marconi Space with the aim of developing a satellite telecommunications network to meet the growing needs of multimedia services.

48. WEST offers an interactive wideband communications network that will initially use one or more Ka-band geostationary satellites that will cover Europe and neighbouring regions. The launch of the first satellite in this network is scheduled for 2002.

49. The WEST network will subsequently be supplemented by a number of geostationary satellites positioned over areas with high market potential and at a later stage, where appropriate, by a constellation of satellites placed in medium-Earth orbit that will make it possible to provide additional services and, in particular, to expand the area of coverage.

50. As part of this project, Matra Marconi Space and CNES have signed a framework partnership agreement for the joint development of the required expertise and facilities, including the necessary technologies, to design, develop and implement new-generation space telecommunications systems. This agreement provides for co-financing by the two partners. CNES and Matra Marconi Space will invest in human and financial resources, research and development budgets and research support loans, with European funding, from ESA in particular.

4. Positioning

(a) Argos

51. Argos, a satellite-based location and data collection system that has been operational since 1978, is aimed at the study and protection of the environment and the development of scientific applications.

52. The Argos system is composed of two satellites and also includes monitoring, data gathering and processing and marketing infrastructures. CNES developed the Argos system, which was produced under a cooperation arrangement with NASA and the National Oceanic and Atmospheric Administration (NOAA) of the United States. The equipment, which was designed and produced by CNES, is carried on board the NOAA satellites. In 1996, the cooperation arrangement was extended to include the National

Space Development Agency of Japan. Under this arrangement, the Japanese advanced Earth observing satellite-II (ADEOS-II), whose launch is planned for June 2000, will carry an Argos instrument that for the first time will provide a buoy interrogation function.

53. The decision was taken in 1998 to begin developing the Argos-3 instruments to be carried on board the United States NOAA satellites and the satellites of the European Organization for the Exploitation of Meterological Satellites (EUMETSAT). This third generation, which will become operational in 2003, will provide users with several new services. Emphasis will be placed on the performance characteristics that only the Argos system can offer, such as miniature beacons and beacons possessing a very long useful life. The new techniques and technologies available mean that significant progress can be anticipated in enhancing the system's performance and in reducing the instruments' bulk, thereby facilitating their installation on board the host satellites. This new generation will see the NOAA television infra-red observation satellites (Tiros) join the meteorological operational polar (Metop) satellites of EUMETSAT as part of an expansion of the cooperation arrangement to include the latter organization. The continuity of the Argos operational system is thus ensured until at least 2010.

(b) International Search and Rescue Satellite System

54. The International Search and Rescue Satellite System (COSPAS-SARSAT), a humanitarian programme based on helping persons in distress, is designed to provide satellite assistance in tracking and rescuing ships, aircraft and land vehicles anywhere in the world. The COSPAS-SARSAT system, which enables signals transmitted by distress beacons to be located very quickly, also alerts rescue authorities, which has made it possible to save thousands of lives since its establishment in 1982.

55. The system, which is made up of a constellation of satellites in low-polar orbits, comprises:

(a) Four United States Search and Rescue Satellite-Aided Tracking System (SARSAT) satellites, with NOAA platforms carrying Canadian instruments operating at a frequency of 121.5 MHz and French instruments operating at a frequency of 406 MHz (search and rescue payloads), situated at an altitude of 850 km and at an angle of inclination of 98°;

(b) Three Russian Space System for the Search of Vessels in Distress (COSPAS) satellites, with Nadezhda platforms and instruments provided by the Russian Federation, situated at an altitude of 1,000 km and at an angle of inclination of 98°. The COSPAS-8 instrument carried on board the satellite launched by the Russian Federation in December 1998 is functioning normally and was declared operational in early 1999.

56. The year 1999 was marked by the decision to start developing the SARSAT-3 instruments, which will be carried by the United States NOAA satellites and the European Eumetsat satellite (Metop-1). The continuity of the COSPAS-SARSAT operational systems is thus ensured until at least 2010.

5. Navigation

57. Satellite navigation systems will make it possible to provide positioning and time-tagging services, a development that entails issues of considerable economic importance. For example, the use of such systems will enable the civil aviation authority to dispense in part with its complex ground infrastructure, which carries high maintenance costs and does not ensure that requirements are sufficiently met.

58. This concept, which is known in Europe as the first-generation Global Navigation Satellite System (GNSS-1), is to be superseded in the longer term by a second-generation system, GNSS-2, in which navigation signals would be processed by a constellation of civilian satellites operating independently of the Global Positioning System (GPS). GNSS-2 would meet civilian users' desire for independence from the United States military GPS and from the Russian Federation's Global Navigation Satellite System (GLONASS). In addition to the requirements of the civil aeronautics industry, a huge increase is expected in demand for marine and, more especially, terrestrial applications.

59. Through its activities at the European level, CNES has greatly contributed to raising awareness of the importance of this field and to formulating a European position. A first stage was the expansion of the United States GPS and Russian Federation GLONASS services by the use of navigation payloads on geostationary satellites and of a dedicated ground segment to supplement the GPS constellation. This was the GNSS-1 programme, under which the European Geostationary Navigation Overlay Service project was aimed at disseminating supplementary data over the region of Europe.

60. The next stage will be the GNSS-2 programme, which will involve the European Galileo (NASA's Jupiter Orbiter) project. This project concerns a civilian navigation system comprising 21 satellites (or more, depending on the level of cooperation), which is the outcome of an initiative of the European Union and ESA. The Galileo performance characteristics will be far superior to those of the current GPS and GLONASS services. They will provide users with an accuracy to within a few metres in navigation and aviation operations, fleet management (trucks, boats and trains), emergency relief and farming (precision agriculture). France attaches considerable importance to this project, which should give Europe its independence in this field.

J. Conclusion

61. At the dawn of the new millennium, outer space is no longer just a place of exploration and experimentation for humankind. In recent years it has become an essential component of everyday life. Whether it be for communications, weather forecasting, natural resource management, environmental monitoring, disaster warnings or rescuing persons in distress, outer space plays a key role in changing human relationships and modes of existence.

62. Space-related applications are undergoing rapid developments. Outer space is at the centre of scientific, technological, economic and political issues. The growth of the information society and the quest for new technologies are giving rise to new requirements. A great deal of present-day activity is linked to the rapid expansion of these flourishing new markets.

63. Together with the new budgetary realities and the maturity of the different operators in the sector, these new trends have already altered—most probably on a permanent basis—the attitude of the major "space-faring" nations, such as the United States or Japan. Alongside their traditional role in the administration of extensive programmes that do not directly meet the needs of the market, States are now seeking to promote the competitiveness of their space industries.

64. France, which aims to remain the driving force behind European space activities, has a major role to play in that undertaking. It has to maintain a scientific community of the highest standard, promote a competitive space industry by maximizing its innovative potential and meet the growing needs of an increasing number of users of outer space.

Jordan

[Original: Arabic/English]

1. Peaceful uses of outer space in Jordan go back to 1970, when the Government of Jordan urged the Ministry of Communications and Transport to introduce satellite communications technology to handle international telephone and television services. Over the last three decades, the field of space science and technology in Jordan has gained significant achievements at the levels both of applications and of education.

A. Space technology applications

2. Space science and technology applications in Jordan cover a number of major sectors, as described below.

1. Satellite communications

3. The first ground receiving station (BQ-1) for satellite communications was established in 1971 in the Baq'a area, 25 km to the north of Amman, with an overall project cost of $4 million. The station served international communications with the Atlantic Ocean Region (AOR) through the International Telecommunications Satellite Organization (INTELSAT) system. A second receiving station (BQ-2) was put in operation in 1979 to handle communications with the Indian Ocean Region (IOR). The budget for this second station, including an upgrade of station (BQ-1) to support dual polarization operations, was $11 million. Both stations were standard "A" stations made by the Nippon Electric Company (NEC) with dishes of 30-32 metres in diameter and four 3 kW TWT transmitters. In 1993, the BQ-2 station was upgraded to operate in digital mode, with multi-beam data collection, at a cost of $2.1 million.

4. As Jordan joined the Arab Satellite Communications Organization (Arabsat) system, a third receiving station (BQ-3) was added in 1985 at a cost of $4.5 million. The station was constructed by NEC and has a diameter of 11 metres, four 3 kW klystrons transmitters and three field-effect transmitted/low-noise receiver (FET/LNR) amplifiers. The station will be digitalized in 2000, when more than 25 low-rate encoding/intermediate data rate (LRE/IDR) routes will be added. The transmitters will be replaced by solid state power amplifiers (SSPA) and the power network will be upgraded.

5. In 1995, a fourth receiving station (BQ-4) was put in operation to replace the first station (BQ-1). BQ-4 operates in digital mode with a 21-metre dish, four 3 kW TWT transmitters, three FET/LNR amplifiers and capabilities for multi-digital IDR carriers (32 routes). A complete power plant consisting of three engine generators of 500 KVA each and new 160 KVA alternating current/uninterruptible power system (AC/UPS) and 100 A direct current (DC)/UPS was added to the site. The overall project budget for this upgrade was $16 million. The table below shows a summary of the characteristics of these four receiving stations.

Major characteristics of the satellite receiving stations

Station identity code	*Satellite cover*	*Number of countries*	*Number of routes*	*Number of carriers*	*Number of channels*	*Television/ radio capabilities*
BQ-2	Intelsat (AOR)	15	21	17	11 FM	2 for TX
					23 Single channel per carrier (SCPC)	2 for RX
					786 IDR-time division multiple access	
BQ-3	Arabsat	12	-	2	40 SCPC	2 for TX
					335 FM	2 for RX
BQ-4	Intelsat (IOR)	18	20	20	3 FM	2 for TX
					395 IDR	2 for RX

6. Over the period 1971-1998, traffic through the Baq'a satellite communications complex has jumped from 24 channels serving 5 destination countries to 1,584 channels serving 52 destination countries.

7. Current and future plans to modernize the Baq'a complex include the following projects:

(a) Time division multiple access (TDMA). This digital equipment will be implemented at BQ-2 for AOR;

(b) Demand assignment multiple access (DAMA) is to be installed at BQ-2 for thin routes;

(c) Digitalization of BQ-3;

(d) Low rate encoding (LRE);

(e) Digital access and cross connect (DAC)

(a) Mobile telephone services

8. A private sector company first introduced this service in 1995. The number of subscribers for 1998 was about 70,000. The number is expected to double if the decision to give the Jordan Telecommunication Company (JTC), a government-owned company, a mobile telephone licence is approved.

(b) Internet services

9. Among the last wishes of the late King Hussein was to see the Internet available at every college and school in Jordan. A dedicated receiving station (Hashem-1) has been put in operation to achieve that goal. On the other hand, current JTC plans to provide

integrated services digital network (ISDN) services will help promote the use of the Internet in Jordan.

(c) Radio astronomy

10. After being replaced with the BQ-4 station, the aging BQ-1 station was allocated for use in radio astronomy research and studies under the supervision of the University of Jordan.

(d) Tele-medicine and remote lecturing

11. In 1996, the Royal Medical Services in Jordan were connected directly with some well known medical centres in the United States of America. Future plans include using the Hashem-1 station to provide remote lecturing services to those who require such service in both the private and public sectors.

(e) Television broadcasting

12. Television broadcasting started in April 1968 with one channel broadcasting programmes in black and white.

13. In 1970, out-door live transmission capabilities were introduced. At the same time, Jordan Television (JTV) started broadcasting special educational programmes for secondary school-level students. In 1972, a second channel for foreign programmes was added. Also in 1972, JTV joined the Intelsat system through the BQ-1 station, making it possible to receive current world news. Colour television broadcasting started in 1971, using the German PAL system.

14. Continuing efforts to increase the area coverage of television broadcasting has resulted in full coverage of the country as well as coverage of significant parts of neighbouring countries. In 1993, a satellite television channel was launched through the Arabsat-1C satellite. Transmission was shifted to Arabsat-2A on the Ku band in 1996. The satellite television channel covers the Arab States and parts of Europe and North America. Satellite television transmission is handled through the Amra satellite station situated within the premises of JTV.

(f) Meteorology

15. Collection, analysis and dissemination of data related to meteorology and climate studies were among the first successful examples of the use of outer space for the benefit of the international community. In Jordan, the use of meteo-satellite imagery for tracking cloud movements was introduced in 1983 at the Department of Meteorology.

16. Since then the Department has acquired several systems for collecting and receiving data on meteorological phenomena. These systems are:

(a) *Secondary data user station*. This was the first system installed at the Department of Meteorology, in 1983, to receive cloud images from Meteosat. The images are received every three hours in three bandwidths, the visible, infra-red and water-vapour bands;

(b) *Primary data user station*. This system was installed in 1990 to receive cloud images from Meteosat every half hour;

(c) *High-resolution picture transmission system*. This system receives cloud images from the satellite of the National Oceanic and Atmospheric Administration (NOAA) of the United States. The images are multi-spectral, with four bands: the visible, near infra-red, middle infra-red and thermal infra-red. The system has been in service since 1994;

(d) *Radio sound system*. The system was installed in 1997 and is used mainly to collect data on weather phenomena in the upper atmosphere (up to 70,000 feet);

(e) *Meteorological data dissemination system*. This system was installed in 1993 and is used to exchange data with other international meteorological centres in France, Italy and the United Kingdom of Great Britain and Northern Ireland through the Meteosat satellite;

(f) *Satellite distribution system*. This system was installed in 1996 at the Queen Alya International Airport to receive data with which to compile aeronautical charts.

(g) Remote sensing

17. The first remote sensing unit in Jordan was established in 1989 at the Royal Jordanian Geographic Centre through a Canadian-funded project. The unit consisted of a mini-computer serving two image-processing workstations, a large-format electrostatic plotter, a scanner and a medium-size film recorder. The project also included the equipment of black and white and colour photography laboratories. Further upgrading of the unit has added a more powerful Unix-based workstation, high-quality software products and enhanced ink-jet plotters.

18. The objective of the remote sensing project was to introduce remote sensing as an important source of data and to demonstrate image-processing capabilities as analysis and problem-solving tools for use in natural resource management and monitoring. This objective was achieved through several pilot projects reflecting the scope of remote sensing applications.

19. Among those first pilot projects were the following:

(a) *Landslide hazards*. The project aimed at mapping the areas subject to landslide along a highway under construction. As a first step, Landsat and Système pour l'observation de la Terre (SPOT) images were used to build up the thematic layers required for land classification. These layers included structural geology, geomorphology, drainage density, vegetal cover, soils and slopes. A combination of geographic information system (GIS) and remote sensing techniques was used to classify the land in terms of its susceptibility to landslide into four categories, ranging from stable to highly unstable;

(b) *Studying the impact of urban expansion into agricultural lands*. A major problem in Jordan over the last 30 years has been the rapid and uncontrolled expansion of built-up areas into the limited agricultural land. The project objective was to generate maps and statistical reports that bring out the impact of urban development on agricultural land and to propose potential directions for future urban development plans;

(c) *Agricultural applications of remote sensing*. Agricultural applications include mapping of land use and land suitability, preparing vegetation index maps, studying temporal changes in vegetal cover, drawing up soil moisture maps and monitoring desertification;

(d) *Geological applications*. These applications are used in producing geological, geomorphological and structural geology maps on scales of from 1:250,000 to 1:50,000.

B. Education and training

20. The introduction of the study of space technology in educational curricula in Jordan, both at the school level and the university level, is still far from satisfactory. The major factors behind this shortcoming are the following:

(a) The cost factor, since hardware and software requirements to set up valid curricula are in general beyond the budgets of many educational institutions;

(b) The lack of qualified or well-trained teachers is a barrier to the inclusion of space science education in curricula at the school level;

(c) The limited local job opportunities for graduates in the fields of space science and technology result in a low demand for education in those fields.

21. Over the last decade, Jordan has witnessed significant developments in the fields of telecommunications, meteorology and remote sensing. Consequently, a growing demand for well-trained personnel in these fields has arisen and emphasis has been placed on the need to promote space science education at the various levels. In this context, elements of space-related sciences, including astronomy, aerial photography, meteorology and space missions, have been introduced into elementary school curricula.

22. At the undergraduate level, remote sensing courses are included in undergraduate programmes in geography, geology, agriculture and engineering at many universities. In 1997, Al-Balqa' Applied University started an undergraduate programme in space geodesy. The programme includes introductory and advanced courses on the Global Positioning System (GPS), remote sensing, GIS and surveying. At the graduate level, it was Al al-Bayt University that took the lead when it established the Institute of Astronomy and Space Science Education, which consists of two space science departments teaching at the graduate level. These are the Department of Astronomy, which offers teaching and conducts research in astronomy. The Department has acquired a small astronomical observatory (a 16-inch LX-200 Schmidt-Cassegrain telescope) and plans to set up a 32-metre radio telescope in 1999. The Department of Space Sciences is in charge of teaching and conducting research on the atmosphere and wave propagation within it.

23. Alongside the academic learning track, progress has been made in providing training in the practical aspects of space technology. The target groups for such training are mainly personnel working in space-related applications or researchers and university students. Training courses are usually organized by specialized training centres such as the Royal Jordanian Geographic Centre, where regular training courses in remote sensing applications and GIS are organized; the JTC training centre, which provides training for its employees and for trainees from other Arab States and the Training Centre of the Department of Meteorology, which organizes courses in weather forecasting (a six-month course) and meteorological observation (a four-month course).

Lebanon

[Original: English]

A. Introduction

1. Lebanon has been actively pursuing a policy of infrastructure reconstruction, especially of its telecommunications systems. The new telecommunications infrastructure is contributing to the development of space-based activities in the economic sector in Lebanon such as television broadcasting by satellite, the Internet and others.

2. In the research sector, the National Centre for Remote Sensing works on the development of the use of satellite imagery in different applications in order to provide decision makers with the data needed for planning and management of the natural resources of Lebanon.

3. The present report of space activities in Lebanon, prepared by the National Council for Scientific Research, is divided into two parts, covering space-related activities in the economic sector and the activities of the National Centre for Remote Sensing.

B. Space-related activities in Lebanon's economic sector

4. As mentioned above, the progress in the use of space-related activities in Lebanon depends mainly on the telecommunications infrastructure and can be seen in the expansion of television broadcasting via satellite (by the Lebanese Broadcasting Corporation and the Future station) and the increasing use of the Internet.

1. Telecommunications sector

5. The Lebanese Post, Telegraph and Telephone has recently replaced analogue equipment by digital technology; upgraded the national transmission network with new copper cables, fibre optic cables and microwave systems; and upgraded the existing signalling network for international network systems.

6. The new telecommunications infrastructure is now able to serve up to 1.5 million potential subscribers.

2. Television broadcasting

7. The two Lebanese television stations, the Lebanese Broadcasting Corporation and Future, have expanded their satellite broadcasting by means of Arabsat-2A, Nilesat (Middle East); Eutelsat, Hot bird (Europe); Panamsat-4 (Africa); and Echostar (America).

3. The Internet

8. The interest in and increased demand for full Internet access on the part of a number of academic, commercial and governmental institutions and individuals indicate that, once access becomes more widespread, Lebanese cultural adaptation to the global community will be instantaneous.

9. There are at present some 30,000 subscribers to the Internet in Lebanon, in particular in Beirut.

4. Meteorological information

10. The Directorate of Meteorology of Lebanon has established a national network of meteorological stations, especially in the Bekaa area. At the same time, the Directorate of Climatology is upgrading its Earth station in order to acquire accurate digital images (Meteosat).

C. National Centre for Remote Sensing

1. Introduction

11. The National Centre for Remote Sensing is an embodiment of Lebanon's focused efforts to come abreast of use of the applications of scientific knowledge and advanced technology, notably in gaining information that will help achieve proper redevelopment of the country. As part of the National Council for Scientific Research, the Centre plays a pivotal role in contributing to the scientific needs of the country, notably in securing data and structured information for redevelopment projects and environmental concerns. The Centre also helps decision makers on actions and policies of relevance for the safe use of space, remote sensing and the Geographic Information System (GIS).

2. Mission and objectives

12. The mandate of the Centre is as follows:

(a) Cooperation with and assistance to public and private sector organizations, institutes and so on in planning and implementing the use of remote sensing and GIS in their operations, emphasizing environmental and cultural concerns, in particular;

(b) Creation of databases from satellite imagery on a timely basis in different areas and disciplines and making the information available to the public and private sector as the need arises;

(c) Interacting and cooperating with remote sensing centres, both regional and international, for the purpose of development, scientific progress and public welfare;

(d) Establishing the necessary in-house and field support systems, laboratories and ground truthing systems for verification of sensed data;

(e) Training and capacity-building of personnel of the Centre as it expands and of personnel of public agencies for other purposes, as the need arises;

(f) Formulating and advising on actions and policies in relation to conventions, protocols, agreements or other matters in the area of remote sensing with regional and international counterparts or Governments.

3. Services

13. The Centre has shared in and contributed to defining needs in areas where remote sensing is applicable in Lebanon with emphasis on public awareness. Similarly, it has assisted other public agencies on relevant matters, notably on the potential of GIS and information technology. Different consultancies have taken shape, notably in designing and implementing projects on or formulating actions as relates to accessing data, identifying archaeological sites, development and assessment studies, maps and evaluation reports on resources (water, soil, iron ore deposits and construction materials); agriculture (land cover and suitability, productivity and yield, rural management and soil

conservation); and the environment (historic monuments, land degradation, soil erosion, forestry, biodiversity, coastal deterioration and natural disasters).

4. Activities

14. New technologies are being used in supplying and upgrading databases and specific information for the different development and cultural areas in Lebanon.

15. The Centre makes use of the wealth of data supplied from remote sensing platforms, converting, rectifying and processing them where necessary in order to meet the requirements of applied research and researchers working to respond to the priority needs of Lebanon. The objective is to serve the community, both public and private, and to ensure full cooperation at different levels. The Centre's efforts in capacity-building, that is, setting up joint ventures, training, technology transfer, information systems and attending and participating in scientific meetings, is a major and ongoing activity. Ground truthing, material verification for accuracy and quality and producing essential documents on an accurate basis, both geographically and scientifically, to comply with the wishes of decision makers for proper development and cultural preservation is a basic part of the Centre's activities. The following section describes projects and themes reflected in the activities of the Centre.

(a) On-going projects

16. Projects in progress include:

(a) Monitoring of the marine environment and creation of a related database (with the United Kingdom of Great Britain and Northern Ireland);

(b) Resources, quality and management of water in the Akkar region (with the Centre d'études, de documentation et de recherches européennes);

(c) Al-Kabeer river basin programme: management of an international border watershed (with Canada and the Syrian Arab Republic);

(d) Programme of training workshops on environmental information systems, GIS and remote sensing (with the German Foundation for International Development);

(e) Management and sustainable use of groundwater and soil and their protection from contamination (with the Arab Centre for the Study of Arid Zones and Dry Lands and the Bundesanstalt für Geowissenschaften und Rohstoffe of Germany (regional));

(f) Study of natural soil resources and soil conservation (local, with regional assistance);

(g) Examination of the economic potential of iron ore deposits lying between the Syrian Arab Republic and Lebanon (regional);

(h) Thermal infra-red survey of freshwater sources in the marine environment (regional);

(i) Application of remote sensing in the Baalbek archaeological area (local, with assistance from Italy and the United Nations Educational, Scientific and Cultural Organization);

(j) Assessment of natural resources in the karst coastal area (Mediterranean, international);

(k) An assessment study relating to certain aspects of seismic activity in Lebanon (international).

(b) Future projects

17. Projects about to be implemented or currently in preparation include:

(a) Tectonic and environmental hazard mapping of the northern segment of the Dead Sea fault system using a digital elevation model (DEM) from ESA remote sensing satellite (ERS) tandem mission synthetic aperture radar (SAR) data (international);

(b) Modelling control mechanisms of climate-land interactions for environmental conservation in the eastern Mediterranean intermontaine region (regional);

(c) Practical approaches to monitoring of marine water quality indicators in Lebanon using remote sensing techniques (international);

(d) Upgrading and centralization of a public sector GIS (local);

(e) Assessment of environmental sensitivity and proper land use of urban coastal areas (regional);

(f) Monitoring indicators of pollution, in particular by hydrocarbons, in the Mediterranean (international);

(g) A pilot study to monitor water quality indicators in Beirut Bay using sea-viewing wide field of view sensor (SeaWiFS) data (international);

(h) Proposal for the development of an environmental information system for Lebanon (international);

(i) Study of astronomical sites at the Midi-Pyrénées-Lebanon Observatory (international);

(j) Applications of remote sensing in archaeology in the region of Tyr (regional);

(k) Pilot project on soil erosion in the Jbeil area (local).

Tunisia

[Original: French]

A. Introduction

1. In seeking to ensure the well-being of its citizens and the country's harmonious socio-economic development, Tunisia has continuously striven to promote new technologies, including advanced space technologies.

2. Tunisia, a constitutional State, has ratified several treaties, agreements and conventions relating to the exploration and peaceful uses of outer space and has become a member of various international and regional organizations that are concerned with space-related activities.

3. Taking into account the recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82), Tunisia realized the importance for developing countries of gaining expertise in the field of space activities, which offers evident spin-off benefits for scientific, economic and industrial development, and, in 1984, set up the National Commission for Outer Space Affairs.

4. In order to establish the conditions for the acquisition of space techniques and technologies, Tunisia has introduced institutional and legal machinery with a view to:

(a) Promoting scientific and technical capabilities and encouraging research activities in various fields, including outer space (the State Secretariat for Scientific Research and Technology (SERST), the Regional Institute for Computer Sciences and Telecommunications (IRSIT), the National Remote Sensing Centre (CNT), the National Engineering School of Tunis (ENIT) and also universities and research centres such as the National Science and Technology Institute for Oceanography and Fisheries (INSTOP) and the Institute for Arid Regions (IRA));

(b) Protecting natural resources and the environment (the Ministry of the Environment and Regional Planning and IRA).

5. Having been entrusted, in collaboration with the ministerial departments and organizations concerned, with the task of proposing a national policy concerning the peaceful uses of outer space as part of the country's development plans, the National Commission for Outer Space Affairs, which was reorganized and reactivated in 1993, has introduced, *inter alia*, a national space programme, whose objectives and achievements form the subject of the present report.

B. National space programme of Tunisia

6. Tunisia has opted for the applications of telecommunications, Earth observation, position location and data collection from among the main activities involving the use of space systems.

1. Objectives of the national space programme

7. The objectives fixed for the national space programme are as follows:

(a) Rational utilization of space applications taking into account the country's economic situation and development priorities;

(b) Creation of a national pool of skills through training in space science and technology;

(c) Development of scientific and technological research in fields related to space systems (electronics, informatics, energy, material sciences, engineering, etc.) and the sciences of the universe, in particular astronomy;

(d) Provision of support to industry in state-of-the-art technologies with the aim of raising industrial competitiveness to meet the challenges of globalization and the market economy.

2. Organization of the National Commission for Outer Space Affairs

8. Under the national space programme, directed by the National Commission for Outer Space Affairs, whose role is to coordinate the activities of the various ministerial departments and organizations concerned with outer space and to generate media awareness of the benefits to be acquired from exploiting the opportunities offered by space technologies, the activities of the different actors involved have been federated by the setting up of five discussion groups, on legal and regulatory aspects; space techniques and technologies; space telecommunications; Earth observation and remote sensing; and training and awareness-raising.

9. These groups have been formed with the aim of bringing about the participation of the largest possible number of institutions having an interest or expertise in the topic of space.

10. The discussions held for the purpose of drawing up the national space programme have involved not only governmental departments but also schools and universities, public and private enterprises, recognized experts, associations of civil society and trade unions.

11. The original composition of the discussion groups was as follows:

Group	*Composition*	*Coordination*
Legal and regulatory aspects	Ministry of Foreign Affairs, SERST, IRSIT, Ministry of Communications, Ministry of the Interior, ENIT, Tunisian Association of Communication (ATUCOM), international lawyer	SERST
Space techniques and technologies	IRSIT, CNT, National Meteorological Institute, Telecommunications Study and Research Centre (CERT), Airports Office of Tunisia, General Directorate of Civil Aviation, Arab Satellite Communications Organization (ARABSAT), ENIT, Faculty of Science and Technology (FST), Tunisian Union of Industry, Trade and Crafts	IRSIT
Space telecommunications	CERT, General Directorate of Telecommunications, National Broadcasting Office, National Remote Sensing Centre (CNT), IRSIT, IRA, ARABSAT, Post and Telecommunications College (ESPTT)	CERT
Earth observation and remote sensing	CNT, IRSIT, ENIT, FST, FSHM, Cité des Sciences	CNT
Training and awareness-raising	Ministry of Higher Education, CNT, IRSIT, ENIT, Association of Young Scientists of Tunisia, ATUCOM, IRA	Ministry of Higher Education

C. Achievements

12. Tunisia has entered the computer age and is already using the information highway. It is now part of the global village, where it intends to be an active player and more than a well-informed consumer. Its main achievements in space-related activities have been the utilization and operation of existing space systems, namely, space telecommunications, location and data collection, Earth observation and research and development.

1. Space telecommunications

(a) Telephone communications

13. For international telecommunications purposes and, in particular, for its telephony services, Tunisia possesses a terrestrial satellite communication station. This station,

which is administered by Tunisia Télécom, can communicate with the satellites of the International Telecommunications Satellite Organization (INTELSAT) and ARABSAT.

(b) Satellite broadcasting

14. Since 1992, it has been possible for programmes broadcast on the national television channel, Canal 7, to be received in Europe, North Africa and the Middle East thanks to transmissions by the National Broadcasting Office via a satellite channel leased from the European Telecommunications Satellite Organization (EUTELSAT). In addition, Tunisia is located in a geographical area providing ideal cover for receiving several international channels. These are accessible to the public and parabolic aerials have now become a component of social life.

(c) Data transmission

15. The National Broadcasting Office has, in cooperation with the Telecommunications Study and Research Centre, set up a project involving the operation of a network for the selective dissemination of multi-service data via the Eutelsat satellite. One of the applications is the transmission of meteorological data provided by the National Meteorological Institute.

2. Location and data collection

(a) Positioning (search and rescue)

16. With regard to search and rescue applications, Tunisia has since 1993 been a user member of the COSPAS-SARSAT International Search and Rescue Satellite System for tracking aircraft, vessels and land vehicles in distress. An operation designed to demonstrate this humanitarian application has been organized with a view to the introduction of a national satellite search and rescue system.

(b) Satellite data gathering

17. Exploiting the opportunities presented by satellites, Tunisia has, through the Ministry of Agriculture, been making use of these services to collect data for mapping, monitoring and evaluating natural resources. In this connection, a pilot remote-sensing project known as the Arid Zones of Tunisia (ARZOTU) experiment, which began in 1975 in Zougrata (now Menzel-Habib), has enabled Tunisia to assess the contribution of the first observation satellites to the study of arid environments. This operation was coordinated by the Agricultural Research Institute of Tunisia, IRA (Tunisia) and the Centre d'écologie et de physiologie énergétiques (France).

18. The General Directorate for Water and Soil Conservation, whose functions involve combating erosion, the harnessing of run-off water and groundwater protection, is administering a scheme to gather climatic data at dams using the Argos data collection and position location system. The information gathered by a network of transmitters provides rainfall, dam water-level and water temperature readings and is used for evaluating and monitoring the water balance.

19. The General Directorate for Water Resources, which is responsible for recording and evaluating surface-water and groundwater resources, operates a network of gauges throughout the country.

20. The General Directorate for Fisheries and Aquaculture, one of whose tasks is to ensure the rational use of fish resources, tested the Argos system for the purpose of satellite fishing vessel monitoring over a period of several months in 1995, in cooperation with the Tunisian Union of Agriculture and Fisheries.

(c) Aviation

21. In the area of navigation positioning, the Airports Office of Tunisia (OPAT), which is responsible for the planning, operation and development of airports and their ancillary equipment and also for regional and local air traffic control in Tunisia, uses the global positioning system (GPS) for air navigation purposes. OPAT is a member of the national committee responsible for formulating a plan to implement future air navigation systems in line with the global plan for the adoption of the new system of communications, navigation and surveillance and air traffic management (CNS/ATM) by the International Civil Aviation Organization.

(d) Tracking of satellites in orbit

22. In addition to making use of space technology applications, Tunisia operates a centre to track the Arabsat geostationary satellites. The main functions of this centre are to monitor and correct the altitude and orbit of the Arabsat satellites. The centre possesses national expertise in geostationary satellite tracking.

3. Earth observation

23. In the area of Earth observation, Tunisia has focused increased efforts on the operational applications of space technology. Meteorology and remote sensing are the main fields of application of Earth observation techniques.

(a) Meteorology and climatology

24. Two key elements in the contribution of satellites to meteorology are global coverage of both hemispheres and continuity of observation. Previously, meteorological data could be gathered only by radiosounding using too few ground stations unevenly spread over the surface of the planet. Deserts, polar regions, oceans and tropical zones did not have any stations for measuring meteorological parameters. The data were partial and lacked continuity.

25. With geostationary and polar-orbiting meteorological satellites the field of vision has been extended; observations have become regular and their quality has increased; the information gathered is rapidly disseminated and instantly processed on powerful computers; and meteorological satellites provide daytime images of cloud cover. In addition, the development of radiometers capable of measuring infra-red rays has made it possible to detect cloud presence at night and on-board sounders have made it possible to determine air temperature and humidity by satellite.

26. Three types of meteorological satellite are used for gathering meteorological data: polar-orbiting satellites equipped with radiosondes; geostationary satellites, which transmit images of the Earth at regular intervals; data-gathering satellites, which broadcast the information received by a number of meteorological stations attached to balloons. These satellites make it possible to carry out meteorological monitoring on a planetary scale (the World Weather Watch programme, consisting of five geostationary satellites and two polar-orbiting satellites of the United States of America).

27. As regard the experience of the National Meteorological Institute (INM) in the operation of meteorological satellites, in order to improve the quality of weather forecasting and to develop its activities at the regional and local levels, INM has over the last five years equipped itself with stations handling the following data:

Type of data	*Stations*
Meteosat high-resolution imager primary data	1 primary data user station
Meteosat secondary data	8 secondary data user stations (at airports)
National Oceanic and Atmospheric Administration data	1 high-resolution picture transmission station

28. The main purposes for which these stations are used are: general weather forecasting; aeronautical protection; very short-term prevention; rainfall estimation; sea-surface temperature readings; and vegetation index readings. INM also uses an ONT channel to disseminate meteorological data and parameters, via EUTELSAT, to the regions in the interior of the country.

29. In addition to the data gathered by the meteorological stations and transmitted across the national territory, INM uses images from the Meteosat satellites and those of the National Oceanic and Atmospheric Administration (NOAA) of the United States for the following purposes: immediate forecasting for the country (1-6 hours); estimating rainfall in regions lacking land-based facilities for measuring precipitation; estimating global solar rays reaching the ground; calculating the vegetation index; and measuring the sea-surface temperature. INM operates a station for receiving and processing images from the Meteosat geostationary satellite and a station for receiving and processing images from the NOAA polar-orbiting satellites.

(b) Remote sensing

30. Remote sensing is an operational application on which efforts have been concentrated with a view to its expansion and utilization in development projects. As stated previously, Tunisia is one of the pioneer countries in this field. For example, alongside the ARZOTU experiment, three national seminars on remote sensing were organized between 1975 and 1982. At a seminar held in 1984 to discuss the issue of remote sensing for Tunisia, it was possible to evaluate and reorient efforts. In particular, it was recommended that a national body be set up with responsibility for coordinating national activities in this field. That recommendation was implemented in 1988 with the establishment of the National Remote Sensing Centre, which has helped to foster the emergence of other users of this technology, who have in turn contributed to the expansion of the applications.

31. Details of the main users are set out below:

(a) The National Engineering School of Tunis, with its space information system and remote-sensing laboratory (LTSIRS), is highly active in the areas of training and research and development in new satellite image-processing technologies. River basins, coastal zones, mining and the environment are some of the subjects studied at this laboratory;

(b) The Institute for Arid Regions, a research and development centre operating under the administration of SERST, has a geographical information and remote-sensing laboratory that uses remote sensing in thematic studies on desertification and natural resource management. The Institute has also acquired considerable experience in the training of users of remote-sensing technology in Tunisia, the Arab world and Africa since 1981. Its efforts received international acclaim in 1986, when the International Society for Photogrammetry and Remote Sensing honoured Tunisia with the Dolezal award, in recognition of the Institute's work in desertification mapping and monitoring in Africa;

(c) The National Agency for the Protection of the Environment and the Agency for Coastal Protection and Development, which are attached to the Ministry of the Environment and Regional Planning, are two of Tunisia's most active bodies in the field of the environment and are hence major users of remote-sensing technology.

4. Training, research and development

(a) Training

32. Under the national space programme, a large number of technicians and engineers have received training in introductory courses on space technologies organized at ENIT and in advanced master's degree and doctorate study programmes in space technologies and the sciences of the universe under bilateral cooperation arrangements.

33. Since 1981, the Institute for Arid Regions has been organizing short-term training courses for national and foreign technicians, in particular from Africa and the Arab world. These courses, which are sponsored by national organizations (SERST, the Ministry of Agriculture, etc.) and international organizations (the Third World Academy of Sciences, the United Nations Educational, Scientific and Cultural Organization, the United Nations Environment Programme, the Arab League Educational, Cultural and Scientific Organization, etc.), have made it possible to provide training for more than 200 participants, in particular in the use of space technologies for development (remote sensing, meteorology, GPS and geographic information systems (GIS)).

(b) Research and development

34. Research and development activities are undertaken at laboratories and research centres. The laboratories set up at schools and faculties have enabled students to carry out work, as part of their theses, on space communications and informatics in the following areas of study: satellite image and data compression (ENIT); information coding and decoding (ESPTT); microwave electronics and antennas (FST); satellite command software (IRSIT); operation of satellite search and rescue services (IRSIT); and satellite meteorological data transmission software (CERT).

D. Regional and international cooperation

35. At the regional and international levels, Tunisia has links with various organizations involved in space-related fields.

1. At the regional level

36. Tunisia is a member of the Regional Centre for Remote Sensing of the North African States, whose headquarters are situated in the country. In October 1998, Tunisia was represented at the inauguration ceremony for the Regional Centre for Space Science and Technology Education—in French language. Tunisia is also a member of ARABSAT, whose secondary satellite control station is located in the country. Tunisia participates in the cooperative information network linking scientists, educators, professionals and decision makers in Africa (COPINE), a project sponsored by the Office for Outer Space Affairs.

37. In addition to the activities of national institutions at the regional and international levels, Tunisia is represented in various events through the activities of associations of Tunisian civil society. The Association of Young Scientists of Tunisia (AJST), which was established in 1974 with the aim of promoting and developing an interest in science and technology among young people through out-of-school activities at laboratories and the organization of scientific camps, operates more than 20 science clubs (space, astronomy, ecology, informatics, electronics, robotics, energy, etc.). In 1998, it joined the Arab Union of Space Sciences and Astronomy. AJST arranges aerospace activities for young people (between 10 and 25 years of age). These activities include the launch of micro-rockets, mini-rockets, experimental rockets and sounding balloons. It also organizes sky observation events as an introduction to astronomy.

38. The Astronomical Association of Tunisia, which is a scientific association, is active in: bringing together amateur and professional astronomers from Tunisia and abroad; publicizing astronomical phenomena; encouraging research in the sciences of the universe; and setting up astronomy clubs.

2. At the international level

39. Tunisia also belongs to and participates in international organizations having an interest in space-related activities, primarily those concerned with telecommunications, namely, the International Telecommunications Union, the International Telecommunications Satellite Organization (INTELSAT) and the International Mobile Satellite Organization (INMARSAT).

40. Tunisia takes part in international space-related events (workshops, seminars and symposia) as often as possible.

41. In addition, Tunisia has ratified several international treaties dealing with outer space activities, including:

(a) Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and other Celestial Bodies (General Assembly resolution 1962 (XVIII));

(b) Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (resolution 2345 (XXII));

(c) Convention on International Liability for Damage Caused by Space Objects (resolution 2777 (XXVI));

(d) Convention on Registration of Objects Launched into Outer Space (resolution 3235 (XXIX));

(e) Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (resolution 34/68);

(f) Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water;[2]

(g) Convention Relating to the Distribution of Programme-Carrying Signals Transmitted by Satellite (the Brussels Convention);[3]

(h) Agreement relating to INTELSAT;

(i) Agreement on the establishment of the International Organization of Space Communications;

(j) Convention establishing INMARSAT;

(k) Agreement concerning the Council on International Cooperation in the Study and Utilization of Outer Space;

(l) Agreement concerning ARABSAT.

E. Remote sensing applications

42. The use of remote sensing technology began in Tunisia, as in Europe, in the 1970s. A remote sensing centre, set up at that time in the Office of Land at the Ministry of Agriculture, has contributed to the training of a body of users through study courses and seminars.

43. The research centres and university have made a significant contribution to the development of remote sensing in Tunisia. Mention may be made in this connection of the efforts of ENIT (LTSIRS), IRSIT and IRA. In 1981, IRA initiated a research programme on desertification mapping and monitoring by remote sensing.

44. Tunisia's efforts were strengthened in 1988 with the establishment of the National Remote Sensing Centre (CNT). The Centre acquires, distributes, processes and stores remote sensing data. It provides services on request and trains personnel of administrative services dealing with remote-sensing applications. CNT, in close consultation and cooperation with its national partners, assists in the implementation of projects dealing with issues of top priority for the country's sustainable development, that is, the environment, resource management, urban planning and land-use management.

45. Since its establishment in 1988, CNT has acquired skills in remote sensing and GIS technologies. The experience and expertise that it has gained in project implementation have been made available to its national partners and shared on a regional and international basis. For example, of the pilot projects carried out by CNT and financed in part through bilateral cooperation arrangements, five study projects have been taken as models and published by the Food and Agriculture Organization of the United Nations in its Remote Sensing for Decision Makers Series, which is intended for divisional directors of national and international organizations and administrations, as well as for project managers, planners and policy makers of development institutions among others, the objective being to present new possibilities for the use of remote-sensing technologies in

[2] United Nations, *Treaty Series*, vol. 480, No. 6964.
[3] Ibid., vol. 1144, No. 17949.

the management and planning of renewable natural resources. These projects are as follows:

(a) Study of marine pollution, aimed at decision makers responsible for the operation and management of coastal areas;

(b) Dynamic study of desertification in the Menzel-Habib region, aimed at decision makers responsible for the development and protection of environments threatened by desertification;

(c) Evaluation of natural disaster damage, aimed at decision makers responsible for the development of areas prone to flooding;

(d) Search for sites suitable for the installation of hill supports, aimed at decision makers responsible for the integrated development of rural areas in semi-arid regions;

(e) Study of urban expansion onto agricultural land in Greater Tunis, aimed at decision makers responsible for urban development and land-use management.

46. The Centre's remote sensing and GIS-related activities involve the execution of research projects and the provision of services on request. The research projects are either national capacity-building or international cooperation projects.

1. Main national capacity-building projects

(a) Southern observatory

47. The purpose of this project, which is financed by SERST and coordinated by IRA, is to develop a dynamic approach to desertification and natural resources. National experts from the university, CNT and the development sector have also participated in addition to IRA. The second phase of the project is currently being implemented as part of a programme entitled "Integrated observatory for arid and desert areas".

(b) Food security

48. CNT has formulated a three-year research programme designed to provide decision makers with a model for early forecasting of cereal crop yield based on remote-sensing and GIS techniques.

(c) Coastal protection

49. CNT has undertaken a three-year research programme aimed at improving the knowledge of coastal areas and the marine environment by conducting diagnostic surveys of coastal strips and classifying coastal zones according to degree of exposure to degradation phenomena, with a view to the implementation of a scheme to provide information and assistance to decision makers in the area of coastal protection.

(d) Forest surveying by remote sensing

50. The aim of this project is to draw up maps of forest and pasture land on the scale of 1:25,000 for the governorates of Jundubah, Bajah and Banzart, in order to facilitate decision makers' planning in connection with afforestation work (resource mapping, databases and GIS).

2. International cooperation projects

(a) Comparative study of desertification in the south of Tunisia and in Sardinia

51. This project, which is being conducted by IRA and the University of Cagliari, Italy, uses multi-date satellite images and reference data to study the dynamics of sensitive Mediterranean environments.

(b) Long-term ecological observatory network

52. This project is being carried out by IRA in collaboration with the Observatory of the Sahara and Sahel. It also forms part of a South-South cooperation arrangement encompassing the Maghreb and the Sahelian countries of Africa. The utilization of remote-sensing techniques provides a tool for survey work, resource monitoring and evaluating the impact of development projects.

(c) Simulation of airborne space technologies for the evaluation, analysis and monitoring of marine ecosystems in the southern Mediterranean

53. This project, which was implemented under the Convention for the Protection of the Mediterranean Sea against Pollution (the Barcelona Convention) of 1976 and is being financed by the European Union, is aimed at establishing tools for analysing the impact of fishing and pollution on the marine environment through the use of an aerospace monitoring system. The purpose of the project is to demonstrate the added value of the system, which uses space and airborne imagery to survey protected and no-fishing zones by the detection, identification, monitoring and management of fishing fleets and the monitoring of oil slicks. The following are contributors to the project: CNT and IRSIT (Tunisia), project members; Thomson-CSF Detexis (France), project coordinator; and the University of Malta, the Polytechnic University of Catalonia, Spain, and the Joint Research Centre of the European Union, project members.

(d) Environment and population dynamics

54. This project, which is financed by SERST and spans a three-year period, aims to provide an understanding of the relationships between people and their environment based on the different uses of natural resources. The study covers four observation sites representative of the bio-climatic and socio-economic contexts of the different countries. The project involves CNT, SERST, IRA, the Agricultural College of Mograne, the Centre for Research, Study, Documentation and Information on Women, the Institute of Forestry and Grazing of Tabarka and INRAT (Tunisia); and the Institut français de Recherche scientifique pour le développement et la coopération (ORSTOM) (France).

55. It will lead to the preparation of: socio-economic and demographic databases; ground-use maps of the study sites; and geographic information systems based on maps on scales of 1:50,000 or 1:100,000.

(e) Changes in Arid Mediterranean Ecosystems in the Long Term and Earth Observation

56. This regional project is an extension of the local research project on satellite monitoring of desertification in southern Tunisia. It aims to develop a methodology for monitoring desertification in the southern Mediterranean that is based on remote sensing and will make it possible to differentiate degraded zones from stable zones and zones undergoing restoration. The project, which will be conducted over a three-year period, will

lead to the mapping of surface conditions in the regions under study, the establishment of a GIS and the modelling of degradation processes.

57. CNT's partners in this project are IRA (Tunisia), URBT (Algeria), the National Agency for Remote Sensing and Space Research (Egypt), the Joint Research Centre of the European Union, ORSTOM (France) and the Institute of Agrometeorology and Environmental Analysis for Agriculture (Italy).

(f) GlobeSAR cooperation project with Canada

58. This three-year project was initiated in 1993 as part of a cooperation arrangement with Canada, its objective being the airborne simulation of imagery from a synthetic aperture radar. The project, which was conducted by CNT, involved several Tunisian partners engaged in different areas that would demonstrate the contribution of radar imaging and its complementarity with optical imaging. The applications concerned environmental appraisal, forestry, desertification, land-use management, soil erosion and moisture, geomorphology, agriculture, coastal erosion, hydrology and geology, among others. The project was also aimed at increasing the capacity of researchers and practitioners to take advantage of the new radar remote sensing technology.

(g) Cooperation project with Spain and Portugal

59. CNT, in partnership with INFOCARTO of Spain and GEOGRAPHE of Portugal, submitted to the European Union a research project for the development of a methodology based on NOAA satellite observations with a view to monitoring and controlling water resources in the Mediterranean basin. The project was carried out over a two-year period (1995-1996).

60. Under this European Union-financed project, CNT was equipped with a NOAA reception station in August 1995. The station, which is integrated into a NOAA data-processing chain, is used for the purpose of obtaining on a daily basis NOAA images, which are then (a) archived, pre-processed, corrected (atmosphere and geometry) and calibrated radiometrically; (b) used for by-products and for obtaining vegetation index and sea-surface temperature readings; and (c) analysed with a view to monitoring the evolution of plant cover, detecting forest fires and determining water currents and marine thermal fronts.

3. Provision of services

61. In addition to conducting research projects, CNT provides, upon request, services relating to the supply of data or products from satellite images. The main services concern the preparation of satellite image maps for national organizations or studies on road or airport infrastructures for planning offices. CNT also provides data and organizes training and skills development courses for students at Tunisian schools and faculties.

4. Future remote sensing projects

62. In view of the results obtained from the projects carried out and the importance of expanding the study to more extensive regions at the national and international levels, a number of projects will be carried out under a programme to be initiated in 1999. The projects at present selected are described below.

(a) Natural resources and desertification observatory

63. This nationwide project, which is nationally funded (SERST) and is being carried out by IRA, is designed to pool the resources and expertise of all the actors involved (universities, research centres, support and development organizations, etc.) with a view to optimizing the research results and presenting them in the most relevant form for use in combating desertification. The specific objective of the project is to help strengthen the capacity for acquiring and analysing multisectoral information, in particular space-related data, and to establish an environmental information system that can guide development and decision-making efforts.

(b) Coastal monitoring system

64. The objective of this project is to expand the coastal protection project carried out on the Gulf of Hammamet to cover the entire coastal area of Tunisia. It is aimed at establishing a system that will make it possible: to prepare a survey of the different components of the coastal environment; to maximize the use of the coastal strip through the simulation of use-planning scenarios; and to monitor fragile environments, ensuring a balance between development and protection.

65. The project will be carried out with the following partners: the Ministry of the Environment and Land-Use Management, the Agency for Coastal Protection and Development and the General Directorate for Regional Planning; and the National Institute of Marine Science and Technology, the National Meteorological Institute and different colleges and faculties.

(c) Remote sensing applied to Tunisian agricultural statistics

66. This project involves the application of the results obtained under the food security project in the Governorate of Bajah to all of Tunisia's cereal-growing areas. The aim of the project is to introduce an agricultural information system that will assist decision makers in evaluating cereal crop yields on a national scale. In addition to the regional agricultural development boards of the governorates concerned, the partners will also include institutes and technical offices of the Ministry of Agriculture.

(d) Mediterranean heritage inventory

67. This European Union-funded archaeological inventory project is being carried out by the National Heritage Institute of Tunisia in collaboration with CNT, ENIT, the Photography Research and Archiving Centre (Italy), the Centre national d'études spatiales of (France) and the Ministries of Culture of Algeria and Palestine. Its aims are the training of technicians from the partner countries in the areas of archaeology, remote sensing and GIS; the preparation of an inventory of archaeological sites; and the production of archaeological databases.

F. Conclusion

68. Tunisia's national space programme, which is now a major part of the national scientific research and technological development strategy, plays a decisive role in the promotion of innovation and the acquisition of appropriate expertise and technological skills with a view to achieving greater efficiency.

69. In the priority area of strategic research, the national space programme is contributing in particular to the success of strategic research programmes in the following spheres: the optimum and sustainable management of national resources; and the protection of the environment and sustainable development.

70. In general, Tunisia's national space programme contributes to the rational exploitation of space technology for the country's sustainable development; promotes the acquisition of space science and technology; and helps support national industry in its efforts to modernize production tools and management methods.

71. Although the activities carried out are commendable, they need to be further strengthened within the framework of more intensive regional and international cooperation. Tunisia relies primarily on its own resources. It is accordingly necessary to increase its efforts in the area of education, ranging from youth awareness of space technologies to in-depth instruction for specialists. A plan to introduce a doctoral programme in space science and technology is under consideration. While relying on its own resources, Tunisia is nonetheless open to cooperation and partnership. Its excellent bilateral and multilateral relationships in the scientific sphere will certainly be further strengthened in the future in order that the spin-off benefits of the exploration of outer space can genuinely be available to all.

Uruguay

[Original: Spanish]

1. With regard to the activities of the Aeronautics and Space Research and Dissemination Centre (CIDA-E), particular mention can be made of the following:

(a) In 1998, CIDA-E signed a memorandum of understanding with the International Space University, under which it will act as liaison office for Uruguay to serve as the contact point between the University and the space community in Uruguay;

(b) Also, CIDA-E has initiated contacts with the European Centre for Space Law of the European Space Agency, with a view to setting up a Latin American centre for aeronautical and space law;

(c) The Planetary Society, in cooperation with the National Aeronautics and Space Administration and the Jet Propulsion Laboratory of the United States of America, is currently organizing an international student competition entitled "Red Rover Goes to Mars", which will enable the young winners to participate in a simulated exploratory mission arriving on Mars on 22 January 2002. Acting as the national centre, CIDA-E will publicize the competition, receive the entries from those wishing to take part and announce the winners of the competition at the national level, who will then participate in the final round together with students from other countries;

(d) CIDA-E has participated in the Subcommittee on Issues of Policy Concerning Communications with Extraterrestrial Intelligence of the Committee on the Search for Extraterrestrial Intelligence;

(e) As an institutional member of the International Astronautical Federation, CIDA-E assisted in the drafting of a document entitled "Space for the World", prepared by the American Astronautical Society, which presents the collective vision of nations as

regards identifying international cooperation priorities in the development of the space sector for the benefit of all peoples of the world.

2. Uruguay participated in the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III), reasserting the principles of international cooperation and, with regard to space law, in a paper presented to the workshop of the International Institute of Space Law by CIDA-E, reaffirmed the role of the Committee on the Peaceful Uses of Outer Space as a maker of space law and the need to fill the legal gaps existing in current legislation, adopting a realistic and conciliatory approach.

3. In 1998, the Space Technology Advisory Committee was set up with the tasks of conducting a survey of the current situation in Uruguay with regard to the utilization of space technology, formulating the framework of a national space plan and promoting projects to that end.

4. One of the projects being promoted by the Space Technology Advisory Committee is the CREPADUR project, the aim of which is to set up a centre for receiving, processing, archiving and disseminating Earth observation data in Uruguay, whose establishment will be supported by the Spanish Agency for International Cooperation and the National Institute of Aeronautical Technology of Spain. It will be possible to implement this project in areas such as the environment, natural resources, crop monitoring, desertification and water quality without the need to request all the information from other countries. The information will be received via two satellites (advanced very high resolution radiometer (AVHRR) and the sea-viewing wide field of view sensor (SeaWiFS)), which will provide land and sea data such as water and ground temperature, vegetation indicators and chlorophyll content of marine algae.

5. The *pro tempore* secretariat of the Third Space Conference of the Americas has continued to carry out various activities.

United Nations A/AC.105/729/Add.2

General Assembly

Distr.: General
4 February 2000

Original: English/Russian

Committee on the Peaceful Uses of Outer Space

International cooperation in the peaceful uses of outer space: activities of Member States

Note by the Secretariat

Addendum

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I. Introduction

1. In accordance with the recommendations of the Committee on the Peaceful Uses of Outer Space at its fifty-fourth session,[1] Member States have submitted annual reports on their space activities. In addition to information on national and international space programmes, the reports could include information on spin-off benefits of space activities and other topics as requested by the Committee and its subsidiary bodies.

2. The information submitted by Member States as at 30 November 1999 is contained in document A/AC.105/729. The information submitted by Member States between 1 December 1999 and 25 January 2000 is contained in document A/AC.105/729/Add.1. The present document contains information submitted by Member States between 25 January 2000 and 7 February 2000.

[1] *Official Records of the General Assembly, Fifty-fourth Session, Supplement No. 20* (A/54/20), para. 119.

II. Replies from Member States

Russian Federation

[Original: Russian]

1. The space activities of the Russian Federation in 1999 were conducted under the Federal Space Programme and also as part of international cooperation programmes.

2. The activities were carried out by the Russian Space Agency (RSA) (in collaboration with the Russian Academy of Sciences), the Ministry of Defence, the Ministry for Emergency Situations, the State Committee on Telecommunications, the Federal Geodesic and Cartographic Service, the Federal Hydrometeorological and Environmental Monitoring Service and other clients and users of space information and services.

3. In the course of the year, the Russian Federation carried out 26 space launchings, as a result of which 46 space objects were put into orbit: 14 of them were Russian (one manned spacecraft of the Soyuz TM series (Soyuz TM-29), two unmanned cargo spacecraft of the Progress series (Progress M-41 and Progress M-42), four satellites of the Cosmos series (Cosmos-2365 and Cosmos-2368), one satellite of the Molniya-3 series, one satellite of the Resurs-F1M series, one satellite of the Raduga-1 series, one satellite of the Foton series, two satellites of the Yamal-100 series and one satellite of the Okean-O series) and 32 of them were foreign satellites.

Main results

A. Manned space flight programme

4. In 1999 the crews of the Mir manned scientific research station continued their work. The experiments and studies carried out on Mir covered all basic aspects of manned space flight programmes, including: (a) space medicine and biology; (b) geophysics; (c) space technology; (d) environmental science; (e) natural resources; and (f) astronomy.

5. The programme of studies in geophysics, natural resources and environmental science included photographic observation and spectrometric analysis of individual land-covered and water-covered portions of the Earth's surface; attention was given to cloud cover, notably to noctilucent clouds, and also to the intensity of subsurface wave formation in the oceans; micro-meteorite fluxes were registered, as were the temperature characteristics and vertical profiles of the atmosphere; the Earth's ionosphere was studied, notably in connection with the characteristics of radio wave propagation; and methods of forecasting earthquakes were developed.

6. The scientific programme of the Mir space station also included measurements of the space-energy characteristics of cosmic radiation as well as measurements of high-energy charged elementary particle fluxes and of neutron fluxes in the station's orbit; galactic and solar flares were registered; and astrophysical studies were carried out in the soft gamma radiation region.

7. Various devices and items of equipment were used to study the characteristics of physical processes, in particular convection, diffusion and heat and mass transport in molten metals and liquids; dynamic load sensors were developed and the characteristics of structural materials and the reliability of on-board equipment exposed to the effects of ionizing radiation were evaluated; finally, hydrodynamic processes in the fuel systems of space objects were studied.

8. Parallel to the research and experimental programme outlined above, preventive maintenance and rehabilitation work were carried out in the course of servicing the space station's equipment.

9. In 1999 the Mir station continued with its twenty-sixth major expedition and New Year 1999 was welcomed in by the Russian astronauts Gennady Padalka and Sergei Avdeev, who had set off to Mir in the Soyuz TM-28 spacecraft on 13 August 1998.

10. On 4 February 1999 the crew performed work connected with the Znamya experimental programme, the purposes of which include further refinement of methods of creating large thin-film structures during Earth orbit and the analysis of possibilities for illuminating dark portions of the Earth's surface from outer space by means of reflected sunlight. The experiment in question was carried out with the help of the cargo spacecraft Progress M-40 following its separation from the orbital station.

11. On 20 February 1999 the Soyuz TM-29 spacecraft was launched from Baikonur, carrying to the Mir orbital station an international team of scientists: Viktor Afanasev (Russian Federation), Jean-Pierre Haigneré (France) and Ivan Bella (Slovakia). In the course of their joint flight, the crew of five cosmonauts carried out a number of experiments under the Russian-Slovak "Shtefanik" programme and then handed over to the crew of the twenty-seventh major expedition.

12. On 28 February Gennady Padalka and Ivan Bella returned to Earth on the Soyuz TM-28 spacecraft. Gennady Padalka's flight had lasted 198 days, 16 hours and 31 minutes; the flight of the Slovak cosmonaut Ivan Bella had lasted 7 days, 21 hours and 56 minutes.

13. The flight of the crew of the twenty-seventh major expedition, consisting of Viktor Afanasev, Sergei Avdeev and Jean-Pierre Haigneré involved the following events, listed in chronological order:

(a) On 4 April the cargo spacecraft Progress M-41 docked with Mir;

(b) On 16 April Viktor Afanasev and Jean-Pierre Haigneré performed a spacewalk lasting 6 hours and 19 minutes and attached the French "Exobiology" device to the outer surface of the Mir station; the purpose of the experiment was to study the interaction of material from meteorites with biopolymer molecules, the results of which, the scientists hoped, might help to clarify the origins of life on Earth. They also put into free orbit an operating model of the first artificial Earth satellite;

(c) On 18 July the cosmonauts docked with the Progress M-42 cargo spacecraft, a further element in the orbital space station carrying additional equipment designed to prepare the Mir station for transition to unmanned flight;

(d) On 23 and 28 July Viktor Afanasev and Sergei Avdeev performed spacewalks lasting 6 hours and 7 minutes and 5 hours and 22 minutes, respectively. The main purpose of the spacewalks was to carry out the "Reflector" experiment to study the steps involved in the deployment and configuration of a new type of large parabolic antenna in outer space conditions;

(e) On 28 August 1999, following the completion of research carried out under the Federal Space Programme and the joint Russian-French Perséus project and further work required to prepare the Mir space station for the transition to unmanned flight, the crew of the twenty-seventh major expedition returned to Earth aboard the Soyuz TM-29 spacecraft. The duration of Sergei Avdeev's flight had been 379 days, 14 hours and 51

minutes; the flight of Viktor Afanasev and Jean-Pierre Haigneré had lasted 188 days, 20 hours and 16 minutes.

14. The scientific part of the programmes of the manned flights in the Mir station included research and experiments in all the main areas of interest for contemporary space flight: geophysics, exoatmospheric astronomy, the study of materials in outer space, medicine, biology and biotechnology.

15. The programme of geophysical experiments involved regular photographic observations as well as making a video recording and carrying out a spectrometric analysis of the Earth's land and water surface and of cloud cover. The characteristics of the atmosphere and ionosphere were also studied. Close attention was given to the study of ecological conditions in highly industrialized regions, to the origins of forest fires and to ocean streams and regions of intense subsurface wave generation. The development of methods for forecasting earthquakes continued on the basis of measurements of cosmic radiation characteristics and analysis of ionospheric parameters. Micro-meteorite fluxes in the orbital path and the overall radiation situation in the station's orbit were registered on a daily basis by automatic equipment.

16. As part of the programme of astrophysical experiments, observations of galactic and extragalactic X-ray sources and solar flares were continued, as were measurements of the space-energy characteristics of cosmic radiation.

17. With regard to work on space technology, great importance was attributed to the investigation of fusion and crystallization processes in various materials in conditions of weightlessness. Alongside these experiments, measurements were made of micro-acceleration produced in the station by the operation of equipment and the activities of the crew. One aspect of the in-flight analysis of materials consisted of studying the effects of exposure in outer space on certain elements of radioelectronic apparatus and on samples of structural materials placed on the outer surface of the Mir orbital station.

18. The medical experiments carried out on board the Mir station have traditionally included studies of the effects of weightlessness on the human body, both in the preliminary adaptation stage and during the whole flight. The reactions of the cardiovascular system, the vestibular apparatus and the central nervous system have been studied, as have metabolic processes and the overall psychological and physiological state of the cosmonauts. A broad range of experiments have been carried out with a view to devising prophylactic methods for coping with the unfavourable effects of weightlessness on human beings during prolonged orbital flight. In order to obtain additional information required for the further refinement of manned spacecraft, regular measurements have been made of noise levels, ionizing radiation, microflora composition and atmospheric parameters in the living quarters of the station and its modules.

19. The programme of experiments in space biology and biotechnology included studies on higher plants, on the effects of weightlessness and other factors involved in space flight on the development of bird embryos and the behaviour of amphibians, as well as research on the genetic characteristics of cells in various biological cultures.

20. During the last two expeditions of the Mir station, a whole range of technological experiments were also carried out. These included, in particular, the development of new regimes for remote control of cargo spacecraft, analysis of the dynamic characteristics of a space system weighing many tons and consisting of a base unit with various modules and transport craft, and studies on the efficiency of solar batteries with various photoelectric transformers.

21. The Mir station is now continuing orbital flight in an automatic regime.

22. In July 1987, the Mir station became the first true manned international space station (the first foreign visitor to the station was a citizen of the Syrian Arab Republic).

23. In addition to the major expeditions of Mir there have been 16 expeditions involving visitors that lasted from a week to a month. Fifteen of them were international in character, bringing to the station representatives of Afghanistan, Austria, Bulgaria, France, Germany, Japan, Slovakia, the Syrian Arab Republic and the United Kingdom of Great Britain and Northern Ireland, as well as the European Space Agency.

24. There have also been nine short expeditions (lasting 3-5 days) involving visitors brought to Mir by the American space shuttles. In the course of those missions, 37 astronauts from the United States of America have spent time at the Mir station (6 of them remaining for prolonged work as members of the major expedition crew); and there was 1 astronaut from Canada, 1 from France, 1 from the European Space Agency and 4 cosmonauts from Russia.

25. Altogether there were 10 American space shuttle flights to Mir: 7 by Atlantis, 2 by Discovery and 1 by Endeavour (for the first flight of Discovery no docking was foreseen).

26. The Mir station has seen 74 spacewalks and 3 exits into space to deal with the Spektr module, which had suffered a decompression failure. The total time involved in those spacewalks and exits was 354 hours and 20 minutes.

27. The spacewalks involved the following participants:

28 Russian cosmonauts;
3 Astronauts from the United States;
2 Astronauts from France;
1 Astronaut from the European Space Agency (a citizen of Germany).

28. The following spacecraft docked with Mir:

1 Spacecraft of the Soyuz T series;
29 Spacecraft of the Soyuz TM series;
18 Spacecraft of the Progress series;
42 Spacecraft of the Progress M series;
5 Modules (Kvant, Kvant-2, Kristall, Spektr and Priroda).

29. During the active lifetime of the Mir station, more than 23,000 scientific experiments and study programmes were carried out under Russian and international programmes, many of them unparalleled.

30. The main scientific work included:

(a) Observation of the eruption of Supernova 1987A in the X-ray spectral range;

(b) Ecological monitoring of the Earth with the help of the Priroda facility;

(c) Radiosensing of the Earth's ionosphere, on behalf of the Russian ionosphere-magnetic service;

(d) Recording of charged particle bursts, which are precursors of earthquakes;

(e) Pilot-scale production of new materials, crystals and alloys in microgravity with the use of special high-temperature ovens: Krater, Gallar, Optizon and Queld;

(f) Prolonged exposure (up to 10 years) of structural materials on the outer wall of the space station;

(g) Investigation of low-temperature plasma in microgravity using the "Plasma crystal" device;

(h) Development of technology for deploying large structures (the Sofora, Rapana and Strombus experiments) and super-light antennas (the Reflector experiment);

(i) Development of a self-contained technical system for producing, on board the station, vital consumables for the crew (water, oxygen, foodstuffs);

(j) Approval of a unique system for sustaining the work capacity of cosmonauts during long flights (up to 1.5 years).

31. The Mir station became a unique flying test site for trying out many technical solutions and technological processes in real conditions—systems and processes that are to be used in the International Space Station:

(a) The Soyuz and Progress spaceships and the American space shuttle have been tested and approved as transport vehicles for carrying crews and equipment;

(b) The interaction of international crews on prolonged flights has been tried and tested;

(c) The technology required for maintaining the station in working condition over a period of many years (about 14 years in this case) has been tried and tested;

(d) Experience in dealing with abnormal situations and ensuring the safety of the crew and the viability of the station has been obtained;

(e) Experience has also been gained with the conduct of a number of international scientific programmes simultaneously by an integrated crew;

(f) Experience has been obtained with the problem of bringing together two different technical schools to create a space technology for joint use;

(g) Technology was developed for the joint control of Russian and American spaceships guided by two ground control stations: TsUP-M (Korolyov, Russia) and United States Ground Control (Houston, Texas, United States).

B. Applied space technology programmes, communications, television transmission and navigation

1. Space communications, television transmission and navigation

32. The orbital network of equipment for space communications, television transmission and navigation includes the space objects Gorizont, Ekspress, Yamal-100 (communications, television); Ekran-M, Gals (television); Gonets (communications); and the Global Navigation Satellite System (GLONASS) and Nadezhda (navigation and rescue operations).

33. In 1999 operation of the long-range telephone and telegraph communications system was maintained, as was the relaying of radio and television programmes and the transmission of data on behalf of various official authorities and industrial sectors of the Russian Federation and international communications by means of the Gorizont, Ekspress, Gals and Ekran-M spacecraft.

34. Activities aimed at finding reliable solutions to problems of communications and television transmission continued to receive priority in 1999.

35. In September 1999 Russia launched the Yamal-100 space objects, belonging to the Yamal Satellite Communications System, designed to provide support for the orbital satellite communications and television network of the Russian Federation.

36. There was continued operation of GLONASS, designed to provide positioning and time-reference support for civilian users at sea, in the air and on the ground.

37. The Nadezhda space satellites continued to operate on behalf of the International Search and Rescue Satellite System (COSPAS-SARSAT), which is designed to provide assistance to vessels and aircraft in distress.

2. *Remote Earth sensing, meteorological observations and environmental monitoring*

38. Priority areas of environmental monitoring are:

(a) Monitoring of factors that govern the weather situation;

(b) Ecological monitoring;

(c) Study of natural resources;

(d) Monitoring of man-made and natural emergency situations;

(e) Efforts to ensure rational utilization of the Earth's resources;

(f) Preparation of a dynamic model of the Earth.

39. At present, satellites of the Meteor, Resurs-O1, Resurs-F, Okean-O1 and Okean-O series are being used in Russia for the purposes of environmental monitoring; photographic observations of the Earth's surface are also being made from the Mir manned space station.

40. In order to deal with environmental monitoring problems as comprehensively as possible, Russia is planning a phased programme for the development and consolidation of all space equipment required for a future system for remote sensing of the Earth that will include the Meteor-3M, Elektro, Resurs-O1 and Okean-O satellites, as well as improved satellites of the Resurs-DK type and small space objects for remote sensing of the Earth.

41. The development and operation of the future system for remote sensing of the Earth from outer space are to be carried out in such a way as to ensure mutually beneficial collaboration with other countries and organizations that have themselves done useful work in the development and utilization of space equipmment for remote sensing of the Earth. This requires effective and economical forms of multiphase international cooperation in carrying out environmental monitoring and issuing warnings of natural disasters—arrangements that will guarantee the required exchange of space data, joint development of international projects and, ultimately, the integration of national space programme resources into a single comprehensive international system for remote sensing of the Earth.

42. Problems relating to the environment, the rational utilization of natural resources and the establishment of a natural disaster and catastrophe warning system have acquired enormous importance. With these aims in mind, work is being done with a view to the modernization of existing space complexes or the creation of new ones for efficient high-

resolution observation of the Earth and all-weather observation of its seas; there is also a plan to involve defence facilities in the solution of social and economic problems.

43. In 1999 the operation of space systems of various kinds continued, including the Meteor series of weather satellites, an oceanographic space object of the Okean-O1 series and the Resurs-O1 device, which monitors natural resources.

44. On 17 July 1999 a Zenit rocket launched from Baikonur carried the Okean-O satellite, a joint Russian-Ukrainian project, into orbit. The purpose of the space vehicle is to investigate the Earth's natural resources, to observe the surface of its seas and to carry out monitoring operations with rapid and efficient transmission of the results to Earth.

45. On 28 September 1999 the Resurs-F1M space object, equipped for spectrozonal and panchromatic imaging, was launched. On 21 October 1999 the craft successfully completed its mission.

46. The first Meteor-ZM space object is nearing completion (launch is scheduled for the third quarter of 2000). This vehicle is also designed for meteorological observations and investigations of natural resources.

47. In 1999 the development and modernization of the principal terrestrial complex for the receipt, processing, storage and distribution of satellite information continued, and work was begun on the creation of a federal centre for remote sensing of the Earth. A number of new facilities have been established for the receipt, processing and storage of data, a system has been created for the collection of Eurasian data and possibilities for the efficient supply of information to users have been substantially improved.

3. Space technology

48. Studies in the sphere of space technology and the physics of weightlessness were directed towards the production in microgravity of new organic and inorganic materials and the refinement of the technologies and equipment required for their production, including commercial production. The use of both manned and unmanned spacecraft for those purposes will make it possible to grow crystals with properties that are unobtainable on Earth, thus providing the requisite scientific and technical process stock for the transition to pilot industrial production of materials in space. The main purpose of establishing the planned space assembly is to complete the development of basic technologies for the production of experimental batches of semiconductors and other items required for practical application in industry.

49. The year 1999 saw a further continuation of work under the space technology programme being carried out with the Foton space vehicle, in which the member States of the European Space Agency are taking part. Semiconductor materials produced in microgravity (cadmium telluride, gallium arsenide, zinc oxide, silicon and others) mark a five- to sevenfold improvement in their parameters in comparison with their counterparts produced on Earth. Biological preparations show a five- to tenfold improvement in purity compared with their analogues on Earth.

50. Technical experiments were continued in 1999 on the orbital space station Mir. A programme of experiments was prepared and a number of on-board technological systems were produced.

C. Space research programmes

51. Fundamental space research provides basic data contributing to knowledge of the universe, the processes at work in it and their impact on Earth. Such research makes possible human endeavours in space and on the celestial bodies and the conduct of manned flights to Mars in the new millennium.

52. Space technology can be used to conduct more detailed study of space radiation and high-energy particles and of solar-terrestrial interaction, as well as of the development of a heliogeophysical monitoring system being planned for the future. Complex research of the Earth's magnetosphere is being continued, in addition to study of the interaction of processes on the Sun and in the circumterrestrial plasma with life on Earth.

53. During the 10 years of operation of the Granat orbital observatory, which completed its work at the beginning of 1999, a detailed study was made of several dozen galactic and extra-galactic sources, representing possible black holes, neutrons stars (X-ray bursters and X-ray pulsars), X-ray novae and accumulations of galaxies and quasars; and a number of interesting and hitherto unknown objects were discovered. For the first time, sources emitting radiation in the annihilation gamma line of positronium were localized.

54. Under the Koronas programme, solar research is continuing in connection with the international Koronas-I project (research on dynamic, active solar processes and the properties of solar cosmic radiation and electromagnetic solar radiation in the radio, visible, ultraviolet, X-ray and gamma bandwidths). This programme will make it possible to obtain data necessary for locating the active parts of the Sun's surface, to investigate and identify phenomena reliably heralding solar flares and thus to reliably forecast solar activity.

55. It is planned to complete the design and launching of the Koronas-F space object. In 1999 work was completed on the international Advanced Photovoltaic and Electronic Experiments (APEX) project (AUOS-3), initiated with the launch in 1991 of the Interkosmos-25 satellite and the Magion-3 subsatellite, to study the effects of modulated electron fluxes and plasma beams on the Earth's ionosphere and magnetosphere.

56. Under the Interball project a system consisting of a tail probe and auroral probe has been set up in space for the purpose of conducting long-term fundamental research on processes taking place under the influence of solar radiation in the geomagnetic tail (upper and tail ends) of the Earth's magnetosphere. This research forms an integral part of the international programme for investigating the nature and mechanisms of solar-terrestrial interaction by means of spacecraft and ground-based observatories in various countries.

57. The probes have been fitted with scientific instruments designed by scientists and specialists from Austria, Bulgaria, Canada, Cuba, the Czech Republic, Finland, Germany, Greece, Hungary, Italy, Kyrgyzstan, Poland, the Russian Federation, Slovakia, Sweden, Ukraine and the United Kingdom.

58. The results of the research are extremely promising, as there is evidence to suggest that changes in the Earth's magnetosphere may be responsible for changes in atmospheric pressure and lead to the occurrence of droughts, cold snaps in various regions of the world and cyclone formations. There is a correlation between these types of phenomenon and fluctuations in animal populations, epidemic cycles, agricultural crop yields and climatic changes. The investigation and identification of patterns and mechanisms of interaction in the behaviour of the Sun and circumterrestrial plasma will provide the key to a closer understanding of the "secret" of life on Earth.

59. In 1999 the programme of experimental research was essentially confined to the study of solar-terrestrial relations and cosmology using the Koronus-I and Interball satellites and also the Conus-A instrument deployed under the Conus-Wind project (involving the American Wind spacecraft) and mounted on board the Cosmos-2367 space object as a supplementary payload.

60. In 1999, using scientific instrumentation on board the Koronus-I satellite, it was possible to take a large number of photographs of the Sun in single-temperature spectral intervals; over 50 solar events (flares, disappearing solar filaments) and the spectra of global solar oscillations were also recorded, together with data on the effects of magnetic storms on the structure of energy particle fluxes in the Earth's magnetosphere. Using the systems on board the Interball, data were obtained on the pattern of disturbance of the magnetopause of the Earth's magnetic field and on the plasma velocity field of solar wind in the tail of the magnetosphere and so on.

61. In addition to fundamental research, particular emphasis is laid on applied research projects for the forecasting of powerful magnetic storms giving rise to hazardous phenomena (induced currents) in power systems, power supply lines and data transmission networks.

D. Commercial uses of space technology in the Russian Federation

62. Space activities provide a basis for extensive exploitation throughout all sectors of the Russian economy of the scientific and technical, production and human resource potential of the rocket and space sector and of advances in space travel, space technology and rocket engineering, rocket and space engine manufacture, industrial engineering, control systems and instrument manufacture.

63. Two main types of spin-off benefit can be identified in the overall picture of ways in which the scientific and technical achievements of space and rocket technology can be redeployed in the national economy:

(a) Functional "space conversion", consisting of the application of the results of space activities, including "dual-purpose" space technology;

(b) Transfer of "high-tech" scientific technologies into different economic sectors.

64. In the first of these two areas, a total of 90 conversion projects have been prepared, 30 of which are functional conversion projects that do not require further development and involve a redeployment of the functions of space systems and their regular specialized equipment for the purpose of accomplishing tasks of a socio-economic or scientific nature.

65. The following space facilities are examples of technology that is contributing to the development of the social and scientific sectors of the economy: satellites for the investigation of natural resources (Meteor, Resurs-F, Resurs-O1, Okean-O, Okean-O1 etc.); communications and television transmission satellites (Gorizont, Ekspress, Yamal, Gonets etc.); space objects used for navigation and geodetic surveys (GLONASS, Nadezhda etc.); and space objects used for tasks relating to space technology and medicine (Foton, Bion).

66. By making appropriate use of space systems and technologies, it is possible to reduce expenditure on raw-material exploration and prospecting by a factor of 8-10, to ensure rapid and environmentally safe exploitation of the country's raw-material base, together with the construction of facilities in the fuel and energy sector, to permit real-time facility control, to perform environmental monitoring and accident prediction functions, to provide

information coverage for emergency rescue services, to monitor and assess the radiation situation in the vicinity of nuclear power plants, to monitor shipping, road and air traffic, to evaluate damage to the environment and the level of expenditure needed for environmental recovery measures and to assess the costs of post-accident clean-up operations.

67. In the second area, work is currently being done in connection with the economic applications of space technology in the Russian Federation with a view to the following:

(a) Utilizing more widely the advances of space travel and space technology (developing modern, competitive systems and equipment for use in civil aviation, sea and road transport, geodetic survey methods, control and communications systems);

(b) Deploying the expertise gained in the field of space and rocket engine design (increasing production in the fuel and energy sector, drawing on the most scientifically sophisticated technologies involved in rocket engine design, high-energy processes and solutions to problems in the areas of heat and mass transport, gas dynamics, materials science and strength of materials, and the design of powerful heavy-duty cryogenic fuel refining and feed systems);

(c) Deploying rocket and space engineering technology (increasing the production of equipment designed for environmental purposes and industrial safety, drawing on unique space and rocket technology to design ground equipment capable of effective use for fire-fighting and evacuation, systems for ensuring the survival and safety of ground and flight personnel at cosmodromes and launch sites, and the use of expertise and equipment required for working with large volumes of toxic and high-energy rocket fuels);

(d) Deploying space instrument technology (increasing production of medical equipment and equipment for the agro-food sector and construction industry, drawing on accumulated scientific, technical and organizational expertise and the advances made in the design of instruments and instrument systems for measurement, control and diagnostic functions in the testing and operation of space facilities).

68. It is planned to employ methods and technologies that will ensure high reliability and long service life in equipment designed for measurement, monitoring and diagnosis of the parameters of various technological processes—equipment with advanced technical specifications matching world standards.

69. Most of the new technologies constituting key elements of the new equipment generation (on-board computers, power sources, photoreceptor devices, new materials and substances etc.) and the most advanced technological processes developed and applied in the space technology sector are fairly general in character, only about 20 per cent of this technology having narrowly technical and specialized functions. Consequently, the potential exists for space technologies to be successfully applied in various sectors of the Russian economy.

70. Of particular interest, for example, are those technologies developed on the basis of highly advanced scientific research (rotational moulding, non-crucible melting, electron-beam and laser sintering, vacuum ion-beam and plasma treatment of products, infra-red photoreceptor devices, microelectronic circuits based on complementary metal oxide semiconductor (CMOS) structures, sensors based on functional electronics, fibre-optic communication lines etc.).

71. The high-strength steels and alloys developed for rocket and space technology, including those developed by means of ultra-high-speed crystallization of gaseous

condensation, beryllium alloys and composites, carbon-carbon composites, environmentally clean heat protection and heat insulation materials, adhesives and hermetic sealing materials have extensive applications in the construction, fuel and energy, transport and medical equipment sectors and in scientific research in high-energy physics.

72. In order to promote the efficient transfer of space technologies to commercial applications in Russia and to stimulate spin-off benefits, a series of interrelated studies have been conducted with a view to creating the necessary economic, organizational and regulatory infrastructure.

73. Work on the transfer of space technologies is being performed as an element of State policy and in accordance with the federal laws on space activities and on conversion.

74. In 1999 enterprises operated by the RSA took part in the 27th International Exhibition of Inventions, New Techniques and Products, held in Geneva, and were awarded prizes for 8 inventions (1 gold, 5 silver and 2 bronze medals) and in the 48th Eureka-99 World Fair of Innovation, Research and New Technologies, held in Brussels, where Russian companies won 11 awards (3 gold and 8 silver medals) and the RSA exhibit was awarded the Grand Prix of the World Periodical Press Organization.

E. International cooperation

75. Russia is participating in programmes for the construction of the International Space Station and in space systems for environmental monitoring, early warning of potentially destructive natural phenomena and other emergency situations, search and rescue of vessels in distress, tracking the movement of particularly important loads and moving objects and controlling the pollution of outer space.

76. RSA, in cooperation with other ministries and departments and enterprises engaged in the development of rocket and space technology, is contributing to international cooperation in the space sector in the following fields: the use of Russian launching facilities to launch foreign payloads; the carrying and insertion into orbit of small foreign space objects (Meteor-3M (1), in conjunction with microsatellite Badr-B of Pakistan, Maroc/Tubsat of Morocco and Tiung Sat-1 of Malaysia); the installation of foreign scientific instrumentation on board Russian space objects (Sage III of the United States on board Meteor-3M (1), Pamela of Italy on board Resurs-O1 (5) etc.); partnership in the establishment of the International Space Station; implementation of the Spektr project in the area of fundamental space research involving broad cooperation with foreign partners; implementation of projects in the field of space medicine and biology (Bion) and space technology related to the production of materials in microgravity (Foton) and meteorological projects; and expansion COSPAS-SARSAT, for rescuing vessels at sea and aircraft in distress.

77. Missions were performed in 1999 on the Mir orbital station under the programmes of the major expeditions with the participation of French and Slovak astronauts. In June 1999 the Mir-Shuttle programme was completed.

78. Work continued in 1999 in connection with the programme to establish the International Space Station. The partners in this major project are Brazil, Canada, Japan, the Russian Federation, the United States and member States of the European Space Agency. In establishing the International Space Station, extensive use is being made of the experience gathered over a period of more than 30 years in the former Soviet Union and Russia in orbital station operation. The operating and permanently manned Mir orbital station has been used for training cosmonauts and astronauts under real space conditions

for future missions on board the International Space Station. The work done over the previous four years in connection with the International Space Station resulted, on 20 November 1998, in the successful launch of the Zarya functional cargo block, which thus became the first element in the newly started construction of the International Space Station in orbit. The Zarya module was designed and tested at the Khrunichev State Scientific and Industrial Space Centre with funding by contract with the Boeing Company. The launching of the Zarya module and its flight control are the responsibility of the Russian partners. In the initial stage of assembly of the station, flight control of the module cluster, power supply, communications and the receiving and storage of fuel are all managed by the Zarya module.

79. Work was conducted during 1999 on the control of the first elements of the International Space Station; at the Baikonur launch site, the second element of the Russian segment of the International Space Station service module is being tested and prepared for launch. The launching into orbit of the service module will make it possible to commence the manned phase of International Space Station operations.

80. In Russia special conditions have been introduced, with regard to the implementation of international agreements in the area of space activities, for the development of international cooperation and the strengthening of Russia's position in the world space market. To date, inter-State and intergovernmental space cooperation agreements have been concluded and are being implemented with 15 States, including Argentina, Brazil, Bulgaria, Hungary, India, Japan, Sweden, the United States and member States of the European Space Agency. RSA has signed such agreements with the space agencies of 14 countries and the European Space Agency. Those agreements provide for the joint conduct with foreign partners of space projects, international space-related trade and the provision of commercial services involving the use of launching facilities, technological guarantees in respect of commercial satellite launches and the establishment of special customs regulations and duty-free importation of goods transported in connection with space cooperation.

81. RSA and the European Space Agency are currently engaged in finalizing a cooperation programme for the collection of remote Earth sensing data from the ERS-1 and ERS-2 satellites for use by scientific organizations in Russia and a number of European countries.

82. In 1999 further work was done on the commercial project Sea Launch with the participation of Russian, American, Norwegian and Ukrainian companies. The first demonstration launch of the Zenit-3SL carrier rocket from the Odyssey sea launch platform took place on 27 March 1999, followed on 10 October by the first commercial launch from the platform, by which the direct television broadcasting satellite DIREKTV 1-R was launched into geostationary orbit. This satellite, manufactured by the American Hughes Space and Communications Company, is designed to relay television programmes to 50 American states.

83. The Odyssey launch platform was located at the time of the launch in the equatorial region of the Pacific Ocean (on the Equator, at 154° W).

84. During 1999, a total of 32 satellites owned by various countries were commercially launched by Russian launching facilities.

United Kingdom of Great Britain and Northern Ireland

[Original: English]

The space strategy of the United Kingdom is contained in the brochure entitled *New Frontiers*, which has been distributed to the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space at its thirty-seventh session.